Hereford Bull

[illegible] Richard Phillips [illegible]

PRACTICAL

AGRICULTURE;

OR,

A COMPLETE SYSTEM

OF

MODERN HUSBANDRY:

WITH THE

METHODS OF PLANTING,

AND THE

MANAGEMENT OF LIVE STOCK.

BY R. W. DICKSON, M. D.

.... Pater ipse colendi
Haud facilem esse viam voluit. VIRG. GEORG. LIB. I.

IN TWO VOLUMES.

VOL. I.

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1805.

TO

LORD CARRINGTON,

BY WHOSE UNREMITTING EXERTIONS

WHILE

PRESIDENT OF THE BOARD OF AGRICULTURE,

VARIOUS

IMPROVEMENTS IN THE ART OF HUSBANDRY

WERE

EFFECTED AND BROUGHT INTO PRACTICE,

THIS WORK,

WHICH HAD THE HONOUR OF RECEIVING HIS EARLY APPROBATION,

IS, WITH PERMISSION,

INSCRIBED BY

THE AUTHOR.

HENDON,
October 19, 1804.

PREFACE.

In consequence of a more perfect acquaintance with the nature of soils, and with the operation of the various substances that are made use of in the business of cultivation, as well as from additional experiments and more close applications of the principles of other sciences, numerous alterations and improvements have been introduced in the different branches of the art of husbandry, and a great variety of new facts, opinions, and conclusions have been brought to the attention of the agricultor. These improvements have, however, been hitherto of little use, from their being scattered and dispersed through innumerable volumes, without method or arrangement to render their connection, or dependence, clear and intelligible.

It has been the object of the present work not merely to reduce such detached facts into better order, but at the same time to bring the practical details and conclusions into a more intimate connexion with the principles on which

they depend; and in this way afford a more connected and systematic view of the various particulars that interest the cultivators of the ground; whether in the nature of implements, the œconomy and convenience of buildings and roads, or in the raising of different kinds of field crops, the cutting and feeding down meadow and pasture lands, and the management of various sorts of live stock. By such means, it is hoped, the knowledge of the principles of agricultural science may be more readily acquired and extended, and the utility and importance of different practices and discoveries be more fully appreciated and understood.

The undertaking has been attended with considerable difficulty, in many instances, from the insufficiency and incompleteness of experiments and the involved state of the facts, which may afford some apology for the imperfections that may be discovered in the execution; but the author has in all cases endeavoured to rest the processes and methods of management which he has had occasion to recommend, on those practical foundations which in his judgment appeared the most certain and correct. How far he may have succeeded in performing the work in an useful manner, he leaves to the candour of those who are best acquainted with

the difficulties that stand in the way of such an attempt. His pretensions are founded on the experience which he has obtained from having practised the Art on an extensive scale, and from the opportunities which he has had of examining it in different parts of his own and other countries.

In bringing together the widely scattered materials, he has been particularly careful to have recourse to the best and most approved works of the practical kind, of some of which he has had occasion to make considerable use. This has been particularly the case in elucidating the principles and practice of draining land; the methods discovered and recommended by Mr. Elkington, and described with much accuracy and correctness by Mr. Johnstone, having been freely employed, as well as many of the plans which illustrate them. To Mr. Beatson and Mr. Crocker he is likewise under similar obligation for various useful observations on the nature of farm buildings and cottages, as well as in the construction of roads. The valuable writings of Mr. Young and Mr. Marshal, and those of many others, have afforded him facts and details of the practical kind where his own experience was insufficient or incomplete.

For accurate drawings of the natural British grasses

he is indebted to Mr. SALISBURY, the able successor to Mr. CURTIS at the Botanic Garden, Brompton. For correct drawings of several breeds of cattle and sheep, he is obliged to Mr. GARRARD and Mr. SCOTT. And the different laws and regulations which relate to agriculture have been carefully selected and digested into order, by Mr. THOMAS WALTER WILLIAMS, an able and intelligent barrister.

From the great attention that has been bestowed in correcting and improving the figures in the plates of implements and agricultural machinery, it is hoped they will be found well adapted to the views of the practical farmer, and will bring him more fully acquainted with the improved means of cultivation.

In regard to arrangement, the Author has pursued that which seemed to proceed from the nature of the subject, without any regard to what has been done by others; his great object being to present to the agricultor, in as narrow a compass as possible, a complete and connected system of husbandry.

October 13, 1804.

INTRODUCTION.

AGRICULTURE, though it has probably made a greater progreſs in this than moſt other countries, is ſtill far from having attained that degree of perfection which might have been expected, and of which it is capable :—much remains to be effected in almoſt every branch. If the ſtate of the art be examined with attention, it will be found that though in particular diſtricts and ſituations its principles and operations may have been well underſtood, and the lands of courſe have been conducted under an improved ſtate of cultivation; yet, that on the whole, but a very ſmall portion of the cultivated part of the iſland has even at this advanced period been brought under a judicious and well-conducted ſyſtem of huſbandry. Immenſe tracts of land of the more rich and fertile kinds may ſtill be met with in different parts of the kingdom that are managed in very imperfect and diſadvantageous methods of farming. It has been ſtated by an able writer* that Great Britain contains ſixty-ſeven millions of acres; ſeven millions of which are taken up by houſes, roads, rivers, lakes, &c., conſequently incapable of cultivation ; and that of the remaining ſixty millions, only five millions are employed in raiſing grain, and twenty-five millions in paſturage, while thirty millions are either completely in a ſtate of waſte, or cultivated " under a very defective ſyſtem of huſbandry."

But it is not merely in regard to the cultivation of the ſoil that the advancement of the art has been ſo ſlow and confined; in other departments or branches its progreſs has been equally limited. In the management of meadow and paſture-lands, and the improvement of the breeds of different kinds of domeſtic animals, except in

* Sir John Sinclair.

particular inſtances, there appears to have been a greater degree of neglect or inattention, though it muſt be allowed that regard is as neceſſary to be had to theſe as to that of arable cultivation; the connexion between them being ſo intimate, that however well a farmer may be acquainted with arable practice, unleſs he at the ſame time poſſeſſes the proper knowledge of improving and keeping his graſs lands in order, and of breeding, rearing, and feeding animals, he muſt manage to very conſiderable diſadvantage. Without this knowledge it is impoſſible for him to diſtinguiſh the different breeds of animals, or know that which is the moſt ſuitable and beſt adapted to the nature, ſituation, and circumſtances of his farm, or to feed them in the moſt proper and advantageous methods.

In the inſtrumental part of huſbandry, though much has been lately done, much is ſtill to be accompliſhed before that degree of œconomy, convenience, and utility is attained that the ſubject is capable of admitting, and which the nature of the art requires. It muſt however be allowed that valuable additions of this kind are daily introducing themſelves.

The cauſes that have produced this ſlowneſs in the progreſs of an art which undoubtedly claims the greateſt regard and encouragement are not only numerous but extremely different in their nature. On a near inveſtigation of the ſubject, it will probably be found that agriculture has however been leſs retarded by the incapacity or inattention of thoſe who have been engaged in the practical part of the profeſſion, than by the different regulations and reſtrictions with which it has been fettered, and which have been ſuffered to continue after the circumſtances that gave them birth have been either entirely changed or undergone very material alterations. It is not, however, on this account to be concluded, that the advancement of huſbandry, as a ſcience, has not been impeded by the influence of other cauſes; it has obviouſly been much reſtrained at all times, and eſpecially in the more early periods of its cultivation, by the want of a clear and explicit knowledge of its principles, and of greater preciſion and correctneſs in the language made uſe of in their explanation. It has been obſerved by an able writer that while a want of due preciſion and diſcrimination is ſuffered to exiſt in the definitions and deſcriptions of thoſe ſubſtances which conſtitute the baſis of agricultural knowledge, it is utterly impoſſible that it can be carried to any degree of perfection as a ſcience. It is from this ambiguity and incorrectneſs in the language of the art, that the cul-

tivators of land in one part of the country are frequently incapable of profiting to any extent by the accounts that are given of what has been done by the exertions of thoſe in another. This is ſufficiently ſhown in what has been done in reſpect to the nature of ſoils; agriculturiſts in general having given ſuch deſcriptions and definitions of them as coincided with the notions that they had formed concerning their nature in their own particular diſtricts or ſituations, rather than ſuch as marked their particular properties and compoſitions*. Knowledge of this kind, however juſt or accurate it may be in regard to the ſoil of the places from which ſuch deſcriptions are drawn, muſt, he contends, be very imperfect in reſpect to others, and of courſe be incapable of any general application or utility. For it muſt be obvious to every one who is in the leaſt degree converſant with the buſineſs of cultivation, that ſoils do not only differ very materially in the nature of their principal ingredients, but alſo in the proportions or quantities in which theſe enter into ſuch compoſitions as are denominated ſoils. Thus the mere aſſertion of a ſoil being clayey, loamy, gravelly, &c., conveys little information, as it does not make us in the leaſt acquainted with either the properties or proportions of the ſubſtances from which they are thus denominated. Beſides, it is known to every farmer that there is the greateſt difference in the nature of clays and other ſubſtances which conſtitute the baſis of ſoils as they exiſt in the ſtate of earth or mould ; the clayey ſoil of one tract of country being extremely fertile and productive, while that of another poſſeſſes the higheſt degree of ſterility and barrenneſs. There are likewiſe very conſiderable differences in the loamy and gravelly ſoils of different districts, which are by no means diſtinguiſhed by ſuch unqualified terms†. For this reaſon it probably is that experience in farming has had a leſs general effect in improving the ſcience of agriculture than may have been ſuppoſed ; and it is perhaps from the ſame cauſe that the principal improvements in the profeſſion have been confined to particular ſituations and diſtricts, from which they have extended themſelves by very ſlow and gradual means.

The difficulty of determining the connexion of effects and their cauſes, and the length of time that is requiſite to fully aſcertain any particular fact or circumſtance in farming are alſo cauſes that have conſiderably impeded the ſcientific progreſs of agriculture. After much labour, time and expenſe have been employed in order to elucidate and aſcertain particular facts of this kind, it not unfrequently

* Anderſon's Recreations in Agriculture, &c. Vol. I. † Ibid

happens that the experimenters are incapable of accomplifhing their objects, or draw fuch conclufions as can be fafely depended upon ; fo various and fo involved are the circumftances that influence the refults of experimental attempts in this fcience. In this way, however, it is remarked, a fort of experience is begotten and tranfmitted in the art which is difficult to be rejected ; but which, if adopted, muft often inevitably lead to error and difappointment in the practice of the farmer. Befides, this, as well as other fciences, has been greatly embarraffed and retarded by details of imaginary experiments and difcoveries, which are very apt to impofe upon the minds of thofe who are not very well informed concerning rural affairs*.

There is likewife, it is added, in the bufinefs of agriculture much confufion introduced by the difficulty which even the beft judges frequently find in making their decifions, where a number of circumftances and caufes are combined, concerning thofe which are effential and neceffary to particular operations and proceffes, from fuch as are merely accidental and of little import. The want of correctnefs too, in regard to the abfolute expenfe incurred in accomplifhing various operations in refpect to any particular object of hufbandry, and the difficulty in many inftances of preferving the products of different trials diftinct, have had a tendency to impede the advancement of the art ; as from fuch inaccuracy the farmer is frequently incapable of afcertaining, with any degree of exactnefs, either the fum which he has expended or the value of the produce which he has obtained ; confequently he cannot be in a fituation to eftimate the advantages of fuch operations or proceffes, from which the profeffion remains where it was before the commencement of his attempts. The want of accuracy and precifion in matters of this kind has alfo led to the introduction of an extremely pernicious fyftem of proceeding in different inftances, which is that of making conclufions by a fort of guefs-work. Nothing can however be more fallacious than this mode of deciding ; becaufe a perfon under fuch circumftances is almoft certain to be influenced by fome preconceived opinion refpecting the particular object of his decifion †. Facts collected and afcertained in this way, as they can but feldom have any folid bafis, muft of courfe greatly retard the progrefs of agriculture. The conclufions that are drawn by means of experiment are even frequently liable to objection, and hence the improvement of the profeffion is not fo much promoted by this method as many perfons may fuppofe. In making fuch experiments as are to elucidate and explain the facts in

* Anderfon's Recreations, Vol. I. † Ibid.

this ſcience which are doubtful or not well underſtood, much knowledge, care, and circumſpection is conſtantly neceſſary on the part of the experimenter, to guard againſt every thing that may in the leaſt degree influence the reſult: for if this point be not carefully attended to, very different concluſions may be drawn from the ſame experiment. The farmer, from his not having been accuſtomed to that accuracy and preciſion which is requiſite in this mode of inquiry, is often but indifferently prepared to avoid errors, which may be produced by a variety of unſuſpected cauſes, which conſiderably influence the reſults of his trials. On this account the inductions that are drawn from the experimental attempts of even real farmers can ſeldom be ſo fully depended upon as may at firſt ſight be ſuppoſed: where due care and attention are beſtowed, this is, however, the beſt and moſt certain means of increaſing our knowledge, and extending the bounds of the art.

The want of a better and more complete knowledge of the different branches of ſcience which are intimately connected with that of agriculture, among practical farmers, has not been leſs prejudicial to the improvement of huſbandry, by the incorrectneſs and inattention which it may have cauſed in the aſcertaining of particular facts and circumſtances in the profeſſion itſelf, than by the prejudice and attachment which it has engendered to particular cuſtoms, practices and methods of management. The minds of thoſe who ought to have been the moſt capable of enlarging the bounds of agricultural knowledge have frequently by this means been fettered, and kept from taking any new or particular views of the various objects and operations of huſbandry. And this is perhaps one of the cauſes of farmers having proceeded ſo much in the ſame track ſince the commencement of the art.

That agriculture is capable of being advanced to a conſiderable ſtate of improvement, by a more correct and general application of ſuch principles and reaſonings as are borrowed from other ſciences with which it is connected, is extremely probable from the ſucceſs and progreſs that has been made by the little that has been already done in this way, as well as from what may have been obſerved to take place in conſequence of ſuch application in other arts.

After this curſory view of the principal cauſes which appear to have impeded the advancement of agriculture as a ſcience, we may proceed to thoſe that operate againſt its extenſion and improvement as a practical art. Impediments of this kind are however ſo exceedingly numerous and complicated, that it is not intended

to enter into any full or elaborate difcuffions refpecting them; but merely to bring them to the notice of the agricultor.

It is eafy to perceive that a variety of obftructions muft have been thrown in the way of agricultural improvement, by thofe flow and imperceptible changes that are continually taking place in the fituation and circumftances of a country, by which laws, regulations, and reftriction that were once proper and ufeful, become in the courfe of time highly detrimental and improper. From this caufe it is that the early regulations that were made in refpect to the management of lands in this ifland, are fo badly adapted for promoting the advantages of hufbandry at the prefent period. This is fully exemplified in the cafe of commons. The ground in fuch inftances does not merely lay in the ftate of wafte, being debarred and deprived of undergoing any cultivation, although frequently very capable of admitting of it, but it is detrimental by preventing improvements in the adjoining lands from being carried on in the moft complete manner and with the fulleft effect, as well as by being expofed to injuries of the moft baneful kind by the cutting away and removal of its furface, the finking of pits, the ftagnation of water, as well as a thoufand other practices, while the nation derives not the fmalleft advantage from it in return for fuch a fyftem of deterioration.

But it is not only in this point of view that commons are prejudicial or ufelefs; they are a kind of property that has much effect in injuring the morals of the poorer claffes of inhabitants who claim rights on them, by engendering quarrels and difputes, and relaxing thofe habits of induftry, economy and exertion, which are effential to the labourer in hufbandry, by holding out to him a fallacious means of fubfiftence.

There is alfo a kind of *commonable* property which in fome counties appears, from the late excellent furveys that have been made, to be nearly one half of their whole arable territory; in which each individual knows indeed the limits of the lands that he poffeffes, but is under the neceffity of fubmitting to certain regulations and reftrictions that cuftom has eftablifhed, however abfurd or difadvantageous they may be in the cultivation and management of them. This circumftance, inftead of exciting the farmer to induftry and improvement, tends very materially to leffen his exertions and introduce flovenly modes of practice highly prejudicial to the interefts of agriculture. Lands conducted under fuch a fyftem of management cannot probably be made to produce one half the quantity of grain or other fubftances, which they might be made to do under improved methods of cultivation.

That great inconvenience and much difadvantage, in a natural as well as individual point of view, arifes from the poffeffion of lands clogged with fuch cuftoms, cannot be doubted; but perhaps the greateft mifchief is the reftraint which is thus impofed on the art of hufbandry.

The tenures of land, in many inftances, are not lefs injurious to the advancement of agriculture than the circumftance of grounds being wafte or in a commonable ftate. A large part of the land of this country is held under lords of-manors, by a kind of copy-hold or cuftomary tenure which fubjects the tenants to the payments of fines on the deceafe of the lords or tenants, and on the alienation of the property, as well as certain annual rents, and in fome places even to the performance of various difagreeable fervices; from which it is impoffible that the holders of lands under fuch reftricted conditions, efpecially where the lords are entitled to fines proportioned to the improved value of fuch property, can be difpofed to the expenditure of money, or the ufing of much exertion in order to bring fuch lands into an improved ftate of hufbandry. It has been juftly obferved that, "one great obftacle to improvement, arifes from a laudable anxiety in the cuftomary tenants to have their little patrimony defcend to their children. Thefe fmall properties, loaded with fines, heriots, and boondays, joined to the neceffary expenfe of bringing up and educating a numerous family, can only be handed down from father to fon by the utmoft thrift, hard labour, and penurious living; and every little faving being hoarded up for the payment of the *eventful fine*, leaves nothing for the expenfe of travelling to fee improved modes of culture; to gain a knowledge of the management and profits of different breeds of ftock; and to be convinced by ocular proofs, that their own fituations are capable of producing fimilar advantages: and even fhould they be half inclined to adopt the new practice, prudence whifpers, that fhould the experiment fail, it would require the faving of many years to make good the deficiency*."

Such lands too as are held under corporations, whether they be civil or religious, as they do not afford the occupiers of them that kind of intereft and fecurity which becomes the ftimulus of exertion and improvement, are of courfe detrimental to the progrefs of the profeffion. In lands of this tenure no exchanges for the purpofe of mutual accommodation and advantage can be entered into; no improvements in the way of cutting canals or laying out roads can be fafely made without the

* Modern Agriculture, Vol. IV.

intervention of the legiflature. But what is ftill more hurtful, leafes of very fhort periods can only be granted; from which circumftance fuch lands muft conftantly remain under very imperfect fyftems of management.

The poffeffion of lands under deeds of entail may likewife be confidered as prejudicial in the fame way; as in fuch cafes no inducement is held out for the expenditure of money, and the confequent improvement of fuch property.

But obftacles of a more general and powerful nature are found in the various indefinite claims that are made on lands. The payment of tythes in kind, from its operating directly as a tax on the capital and productive labour of the farmer and land-proprietor, as well as from its being vexatious in the mode of its collection, is a meafure that impedes the improvement of the art of hufbandry in a very ferious degree. In the cultivation of arable farms, efpecially if the land be in fuch a condition as to require the expenditure of large fums of money in the purchafe of manure, and confiderable labour and exertion in other refpects in order to bring it into the ftate of producing abundant crops, its effects are experienced in the moft injurious and oppreffive manner. The efforts of the hufbandman in this cafe have been "compared to thofe of a labourer, who fhould make confiderable exertions during the hours of relaxation throughout the day, in order that he might obtain a bit of fomething hot for fupper; and when he was juft preparing to enjoy his hard-earned morfel, he had it taken away from him by a neighbour, who ftood by idle all day, and now came, by means of a legal authority he had obtained as a reward for fome exertions of his predeceffors, when the ftate of fociety rendered fuch a mode of remuneration the eafieft of any that could then be devifed, to feize that which the poor man gained by the fweat of his brow. Though the poor man is forced to give up his morfel in this cafe, it is impoffible for him to yield it without reluctance, or ever after to view his neighbour with a favourable eye. It provokes an inviduous parallel to be drawn between the two parties, which eftranges them the more from each other. The confequence is, that although, in this particular circumftance, the one gains juft as much as the the other lofes; yet it tends very little on the whole to the emolument of the receiver; becaufe the loofer fays within himfelf, fince I cannot enjoy my own morfel myfelf, I can at leaft prevent my neighbour from getting it, for nobody can compel me to earn it but if I pleafe. So down he fits in indolence; and neither of them enjoys the bleffing that might have refulted from induftry*."

* Anderfon's Effays, Vol. III.

The ſpirited cultivator may be inclined to improve his lands, as is frequently the caſe, even where the profit he is to derive from ſuch improvement cannot be conſiderable; but under ſuch circumſtances he muſt conſtantly be prevented from proceeding by the operation of this injudicious regulation: where a tenth or more of the produce ariſing from the exertions of the improver are to be taken away, it is obvious that ſmall returns will not anſwer; eſpecially in a buſineſs where there is much riſk from ſeaſon and other cauſes. By this means the community is conſequently deprived of the various advantages reſulting from increaſed induſtry and augmentation of produce. By the ſame ſyſtem alſo, much good land, excluſive of commons and waſtes is conſtrained to remain in the unprofitable ſtate of graſs, which might otherwiſe, by a trifling expenditure of money, and no very extraordinary degree of exertion, be rendered greatly more productive under proper arable management. And it is likewiſe highly injurious in many inſtances, by ſubjecting the farmer to a diſguſting dependence on the tythe-owner.

It is evident that the effects of this meaſure muſt be equally detrimental to the intereſts of the proprietors of lands as to thoſe of actual farmers; for whatever tends to leſſen the exertion and induſtry of the latter muſt neceſſarily diminiſh the incomes of the former, and in a proportion much greater than is commonly ſuppoſed. But they are injured in another way beſides that of rent; for as a tenth of the produce of the lands is thus taken away in kind, a deficiency of manure to that extent muſt be the conſequence, the diſadvantages of which are now generally well underſtood. The effect which the abolition of tythes in Scotland has had in promoting agricultural improvements, alſo affords a ſtrong and ſatisfactory proof of their operating powerfully againſt the advancement of huſbandry; for it cannot be attributed to any other circumſtance that improvements have been carried on ſo much more extenſively in that part of the iſland than in this.

But it is not merely in ſtopping the progreſs of agricultural improvements that the payment of tythes in kind is prejudicial, its effects are injurious in many other points of view which it is unneceſſary to conſider at preſent. It is therefore a matter of the utmoſt importance that ſuch an alteration or modification ſhould be effected as might render the claims of the proprietors ſecure, without producing thoſe miſchievous conſequences which proceed from it in its preſent form*.

* An able and ingenious cultivator, the Rev. H. J. Cloſe, has ſuggeſted a plan for the removal of the payment of tythes in this way, which, from its nature and ſimplicity, ſeems to deſerve our attention. The Communications to the Board of Agriculture, Vol. III.

The prefent method of providing for the poor, notwithftanding the judgment and deliberation with which it was adopted, is unqueftionably detrimental to the advancement of agriculture, as well as greatly prejudicial to morals and induftry, from its falling difproportionately heavy on land-holders of every defcription, nearly three-fourths of the whole amount of the immenfe fum being raifed by that clafs of fociety. The proprietors of land, are however, in fome meafure enabled to throw this burthen from themfelves by ftipulating with their tenants for the payment of all parochial taxes, fo that in fact the farmer becomes the principal fufferer, efpecially in cafes where any augmentation of the affeffment is required, which is frequently the cafe from the operation of either local or general circumftances; fuch as the failure of manufactures or the carrying on of wars*. By thefe means the capital of the farmer is diverted from its proper application, that of being employed in the cultivation and improvement of land, by which the progrefs of hufbandry is not merely impeded, but the community fuftains an incalculable lofs.

There are ftill other obftacles which retard the improvement of the art befides thofe that have been noticed; but they are in general lefs prejudicial in their tendency, or more limited in their operations. Of this kind are the game, the corn, and the falt laws; all of which in their prefent forms throw great impediment in the way of agriculture. And the want of proper and convenient markets in many fituations, for the difpofal of different kinds of produce, and of eafy and expeditious modes of conveying them to fuch places, as well as a variety of local cuftoms and regulations, are not lefs injurious in their effects ,though much lefs attended to.

Thefe are fome of the principal difficulties and impediments that have been fo long fuffered to retard the progrefs of cultivation, and which muft continue to put an infuperable bar to its improvement, in many refpects, until they are removed.

But the advancement of agriculture has not been folely obftructed by caufes of this nature; there are many others which the proprietors of lands have the means of obviating. The want of proper and judicious leafes has at all times operated unfavourably for the improvement of hufbandry, and is an evil very generally complained of by farmers, a circumftance which is not in the leaft to be wondered at, as it can hardly be fuppofed that improvements will be carried on to any extent

* Modern Agriculture, Vol. IV.

where there is a want of permanent fecurity for the enjoyment of thofe advantages that may be derived from them.

It has been juftly remarked by Mr. Donaldfon, that "that man would certainly be juftly fubjected to the reproach of being rafh and inconfiderate in his conduct, who fhould expend money and labour on the improvement of any farm, where his certainty of continuance does not entitle him to look forward with a confident affurance to the period when his exertions are to be rewarded. It is a well-known fact, that the hope of reward fweetens labour; take that away, and the fpur to labour ceafes. It is that alone that calls forth induftry, and is the fpring of all exertion. What object then can a farmer have to hazard his capital, and devote the moft vigorous and active part of his life to the improvement of a farm which he holds on no more certain tenure than the will, or, in other words, than the whim or caprice of his landlord? In every fuch fituation, the prudent farmer muft be reftrained from any fpirited expenditure, however much he may be fatisfied that the improvements, which might thereby be effected, would, under other circumftances, prove beneficial to the public, the landlord, and himfelf. Have not inftances occurred, where tenants fo circumftanced have been obliged *repeatedly* to agree to pay advances of rent rather than remove; while, from the uncertainty of the tenure on which they held their farms, they were debarred from making thofe exertions which an advance of rent demanded, and which almoft uniformly takes place in fuch cafes when leafes are granted?"

From an examination of the excellent furveys that have lately been made of the agricultural ftate of the kingdom under the direction of the Board, it appears that by far the greateft part of the land in many counties is held by tenants merely at the will of their landlords, who of courfe may deprive them of their farms, on proper notice being given, whenever they pleafe; and in cafes where leafes are granted they do not extend further than from five to nine years, except in a very few inftances indeed, in which they may be protracted to the period of nineteen or even twenty-one. And even fuch leafes as thofe are for the moft part clogged with fuch reftrictive claufes and conditions as put a ftop to improvement, and confine the cultivator in methods of management that are frequently far from being the moft advantageous*.

In the firft cafe, indeed, the farmer is kept in fuch a ftate of dependence as is not only highly degrading, but muft effectually damp and reprefs his exertion and induftry. And the tenants under fhort leafes are not in fituations much more defirable, as they cannot with fafety or propriety enter into any extenfive beneficial

* Modern Agriculture, Vol. IV.

methods of augmenting the produce of their farms, left the advantages ſhould be reaped by others. Even a leaſe of twenty-one years, in many ſituations and under different circumſtances, is not ſufficient to allow the farmer to undertake improvements of conſiderable magnitude, as he can neither conduct them in the moſt economical way, nor reap the full advantage of them. Beſides, where money to any great amount is expended in the beginning of ſuch a term, the farmer is often, in order to indemnify himſelf, where he has not a proſpect of remaining, induced to run out and exhauſt the land at the latter end of his leaſe; which is a practice of the moſt prejudicial tendency to the proprietors of ſuch farms, and the community as well as the intereſts of agriculture.

It is evident, therefore, that the farmers of land ſhould in *all* caſes have ſuch a ſecurity for the poſſeſſion of it as will enable them to introduce the moſt improved modes of management, and excite them to adopt the beſt means of improvement. The length of leaſe that may be moſt ſuitable and beſt adapted for theſe important purpoſes is not eaſily aſcertained; it ought probably to vary according to the particular circumſtances and the nature of the improvements that are to be carried into execution*. In ſuch leaſes many clauſes muſt of courſe be requiſite: but they ſhould be ſuch as are plain and ſimple, and ſuch as may not too greatly deſtroy the independence of the farmer, but leave him much at liberty to follow his own plans of cultivation; while they afford effectual ſecurity to the proprietors, by cautiouſly guarding againſt the introduction of ſuch ſyſtems of huſbandry as would be injurious or improper†.

There are many other cauſes of this kind that operate unfavourably for the extenſion of agricultural improvements; but as they are either confined to particular circumſtances, or only poſſeſs a local influence, it is not neceſſary to conſider them with a view to the preſent object.

From what has been obſerved, it is evident that different circumſtances muſt be attended to, in order to bring the ſtate of agriculture to that degree of perfection which its utility demands. It will not only be neceſſary that the principles of the art be rendered more clear and eaſily acceſſible to the cultivator, but that the various proceſſes

* Mr. Donaldſon, after making a variety of uſeful obſervations on the advantage of leaſes, and the length of time that may have the moſt beneficial effects in promoting improvements, concludes, that "that duration of leaſe which entitles the tenant to commence his improvements with ſpirit, and is not of ſuch a length as to induce him, from any fortuitous circumſtances that may take place, as a riſe in the nominal price of produce, or a fall in the value of money, to ſlacken his attention, may be conſidered upon the whole as beſt; and probably twenty years is as equitable a term as in the preſent ſtate of Britiſh agriculture can well be fixed upon."

† See Section on Leaſes, in Appendix.

and practices be brought into a more obvious and intimate connection with them, and more full and complete explanations of the nature and constituent properties of the different substances or bodies that enter into and form the basis of the profession, afforded; as well as the different clogs and impediments, which have been interposed at different times, in the way of regulations, obviated and removed. The author has endeavoured as much as possible to furnish the farmer with a more correct knowledge of the qualities and methods of operation of those materials or substances with which he is to accomplish his various purposes, as well as the changes which they undergo by an intimate combination with each other; and the modes in which they may be applied and made use of with the greatest chance of success and advantage.

The former of these have been objects of much consideration in the present work. It has also been his wish to extend the bounds of his information in respect to the means of cultivating the different plants which constitute the food of man, or which serve for the purpose of feeding cattle and other domestic animals. In this intention, the various improvements that have been effected in the nature of tillage, and the interposition of different sorts of green crops with those of the grain kind, as well as in the implements and machinery by which they may be performed with the greatest economy and convenience, have been brought to his notice in as clear and concise a manner as the nature of the subjects admitted.

And as the various products of the earth can only afford a trifling advantage to the cultivator, unless he be perfectly acquainted with the means of applying them as the food of animals, the methods of management that appear the most beneficial in the breeding, rearing, feeding, and fattening different sorts of live stock, have, it is hoped, been more fully explained, and placed in more clear and distinct points of view.

In regard to the latter, or the removal of those obstacles which have been thrown in the way of agriculture under the idea of regulating its operations, however necessary it may be to the complete improvement of the art, it can only be effected by the interposition of the legislature and the proprietors of land.

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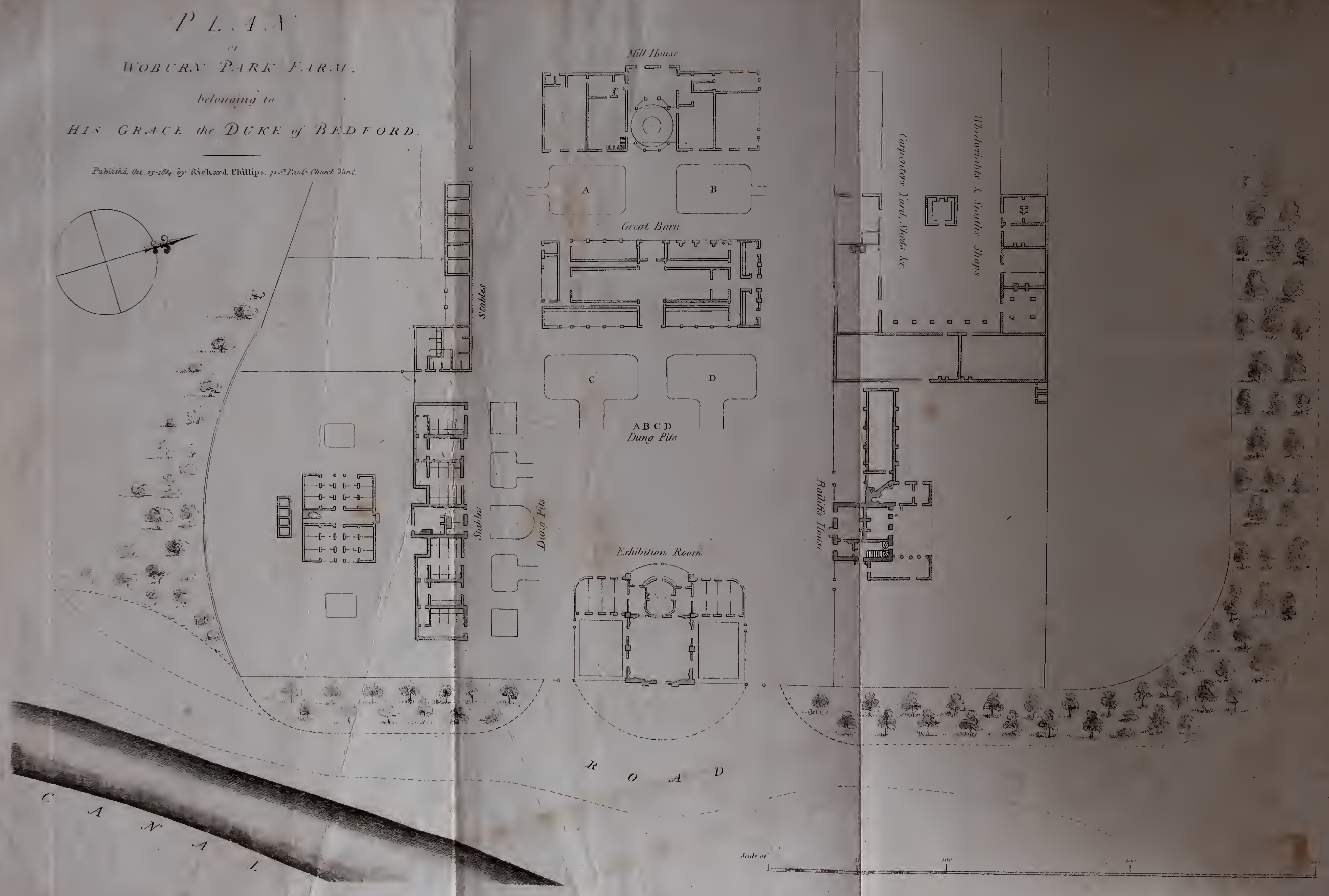
PLAN
of
WOBURN PARK FARM,
belonging to
HIS GRACE the DUKE of BEDFORD.
Publish'd Oct. 25. 1804. by Richard Phillips, 71 St. Paul's Church Yard.
Mill House
A
B
Great Barn
C
D
A B C D
Dung Pits
Stables
Stables
Dung Pits
Exhibition Room
Carpenters Yard, Sheds &c.
Wheelwrights & Smiths Shops
Bailiffs House
ROAD
CANAL
Scale of
100

PRACTICAL AGRICULTURE.

SECTION I.

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THERE is fcarcely any part of the extenfive and important fcience of agriculture that has received greater improvements within thefe few years, than that which relates to the conftruction of the implements which are neceffary to be employed. Since a tafte for the art has fortunately been diffufed through the country, and men of great knowledge and fortune have been induced to engage in it, perfons of ingenuity and mechanical talents have been brought forward and fufficiently encouraged to exert themfelves either in the improvement of the better kinds of the old inftruments, or in the invention of new ones, by which means more convenient and ufeful inftruments and machines have been provided for almoft all the various operations and proceffes that are continually to be performed in cultivating land, and managing the different kinds of bufinefs neceffarily connected with it. Among the variety of different implements which have been thus prefented to the attention of the agriculturift, fome, as may eafily be conceived, have appeared, that are evidently much too expenfive and complicated in their conftruction for the purpofes which they are intended to ferve, and others, probably from a want of practical information in the inventors, have not been properly adapted to the ufes for which they were defigned; but in general they have been fuch as have contributed much to the prefent very improved ftate of the art.

The backwardnefs that may be obferved, and which is fo much complained of in fome particular diftricts in refpect to the ftate of their cultivation, would feem to depend, in fome meafure, on an attachment to fuch implements as they have been in the habit

of employing, however imperfect they may be, in preference to such as have been recently invented or improved. This, in some cases too, may probably arise from the want of capacity in the farming labourer to make use of new tools with ease and convenience to himself; and in others from farmers themselves being frequently unacquainted with the instrumental improvements that have been made, or not sufficiently convinced of the advantages that may result from the use of them.

In the construction of every sort of tool for the purposes of farming, as the chief objects ought to be the rendering the business of husbandry more complete, easy, and expeditious, and the introduction of a system of economy in respect to the labour that necessarily attends it, great care should be taken that they be well adapted to the purpose for which they are intended, and not unnecessarily heavy, while they possess sufficient strength and firmness for the various uses to which they may be applied. It is well observed in an ingenious and interesting periodical publication, that there are no sort of implements that admit of greater improvement than those of husbandry, on the principle of diminishing weight without in any degree abating strength. "Every man knows," says the author, "that if a beam of any length be made of equal thickness throughout its whole length, and a weight sufficient laid upon it, it will inevitably break in the middle, and never at either of the ends; yet, unless it be in the poles of a sedan chair, he can scarcely recollect an instance in which weight has been diminished upon this principle. On the contrary, it is not at all unusual, in the construction of such implements, to see the thickness diminished nearly one half at the very weakest place by means of a mortise cut out in it there, while its thickness in other places is four times greater than would enable it to bear an equal burden. No attention is paid to placing the wood in that position wherein it would be best able to resist the pressure to which it must necessarily be subjected; although it is very well known, that the same quantity of materials may be made to bear in one position above *ten* times as much as it could do in another. It is well known, that mortises weaken the wood to an astonishing degree when injudiciously placed; yet it is no uncommon thing to see two cross-mortises, each of them of twice the size that in any case could have been necessary, made through a beam perhaps at the very weakest parts of it, just as accident may direct, without even an attempt to vary their position, far less to avoid them entirely, which in many cases might be done without the least inconvenience. It is well known that a small brace, judiciously applied, may greatly augment the strength without adding to the weight of an implement; yet contrivances of this kind, which are obvious to the merest tyro in mechanics, seem to be totally disregarded; far less do the constructors of such tools think of adopting new devices of this sort, which a very moderate degree of ingenuity might easily suggest. The importance of having every part firm and compact,

in an implement that is fubjected to jolts and fhaking, is univerfally recognifed; yet, from the moft trifling confiderations, we fee this principle departed from, and loads of fuperfluous materials added, in vain, to fupply the defects that are thus produced." He concludes by obferving, that "it is not to one implement only that thefe obfervations apply, but to almoft every common implement of agriculture *."

The above principles, though extremely plain and obvious in themfelves, are circumftances which feem indeed to have been greatly overlooked by the practical farmer, and too little regarded by thofe who have been principally employed in making inftruments of this nature; as in almoft every diftrict of the kingdom, notwithftanding the many ufeful inventions and improvements which have lately been made, we may ftill meet with different forts of implements that are not only exceedingly awkward and inconvenient from their clumfinefs, but which are ufed with much difadvantage, on account of their great weight: fituation, and fome other caufes, will, however, render a difference in regard to ftrength, and other circumftances, neceffary, and by them the operator muft frequently be guided in the conftruction of tools for the purpofes of hufbandry. As moft of the implements of this kind are made ufe of by perfons who have but little knowledge of the nature, power, or action of machines, and as they fhould be generally in the hands of farmers, they ought always to be conftructed upon the moft plain and fimple principles, of fuch kinds of materials, and in fuch ways, as that they may be afforded at a cheap rate, nothing having operated more unfavourably to the introduction of new implements among this clafs of men, than the great expence that attends the procuring of them.

PLOUGHS.

As ploughing, like many other operations in practical hufbandry, muft often vary in the manner of its being performed, it is evident that no one particular fort of plough can be fuperior to all others, in every feafon, and under every variety of foil, or inclination of furface; different foils, fituations, and ufes, will of courfe require different kinds of ploughs, though there are, undoubtedly, fome that are capable of a much more general application than others. It has, indeed, been obferved by the author of a late work on hufbandry, that "the plough which cofts the leaft money, is the lighteft to trail, and makes the beft work, is of moft value;" which, in general, we believe, may be true†.

In the forming or conftructing of all forts of implements of this kind, there are a few general principles that ought invariably to be attended to; fuch as the giving the *throat* and *breaft*, or that part which enters, perforates,

* Anderfon's Recreations in Agriculture, &c.

† The Experienced Farmer.

and breaks up the ground, that fort of clean, tapering, fharpened form that affords the leaft refiftance in paffing through the land; and to the *mould-board* that kind of hollowed out and twifted form which not only tends to leffen friction, but alfo to contribute greatly to the perfect turning over of the furrow-flice. The beam and muzzle fhould likewife be fo contrived, as that the moving power or team may be attached in the moft advantageous *line of draught.* This is particularly neceffary where a number of animals are employed together, in order that the draught of the whole may coincide.

Swing-Ploughs.—As this fort of plough is not incumbered with wheels, it muft be the moft free from friction, and the refiftance which neceffarily proceeds from that caufe; confequently may, in general, be faid to be the lighteft of draught.

In the conftruction of ploughs of this kind there is, however, confiderable variation in different diftricts; but when they are made of proper kinds of materials, and in the moft improved manner, they muft be allowed to be inftruments of extenfive application and utility. As befides being effective in their operations, they are not fo eafily put out of order as other kinds of ploughs; and, from the circumftance juft noticed, require in almoft every kind of foil, when managed by a good ploughman, much lefs ftrength to draw them than thofe of a fimilar kind when conftructed with wheels; confequently give confiderably lefs fatigue to the horfes, or teams of any kind, that may be employed in drawing them. In the mould-boards of moft of the improved ploughs of this kind, there is that peculiar form of curvature which leffens refiftance in turning up the ground, and which contributes to render the earth of the furrow equally and well laid over to its fituation.

The *rotheram-plough*, *Small's chain-plough*, and a *plough* recommended by the Board of Agriculture, as well as feveral others to be met with in almoft every arable county of the kingdom, are formed in this way.

Light thin foils, with little tenacity of furface, fuch as are commonly employed in the growth of turnips, may be well managed by almoft any of the ploughs that are in general ufe; but as the chief excellence of a plough for this fort of foil would feem to be that of its poffeffing light weight, eafy draught, and being capable of leaving the furface in any defired fhape in refpect to height of ridge, thofe of the light fwing kind ought certainly to be preferred. Ploughs of this fort have for fome time been much employed in moft of the northern counties, and in the fouthern diftricts are now much more frequently met with. In many places they do not coft more than forty or fifty fhillings. That fort of plough which is commonly known by the name of *Dutch plough,* is a light fwing-

plough, which, from its not requiring great ftrength to draw it, may frequently be ufed with advantage on fome of the lighter forts of foil, which are pretty free from ftones and other obftructing matters of that nature. But where the land is of a ftrong, heavy, cohefive quality, and where the roots of vegetables, or other fubftances, afford confiderable refiftance and obftruction, a much ftronger plough muft be employed. Here the *Suffolk iron fwing-plough* will, probably, be found a much better, as well as a very neceffary and ufeful inftrument, efpecially when managed by a judicious ploughman. The advantage of this inftrument has been particularly fhewn in breaking up fome of the ftrong heavy lands of the King's farms in the great park near Windfor. It not only does its work well, but with greater facility than many other kinds of ploughs which are frequently employed on thefe kinds of foil. The part to which the team is attached in this fort of plough is an excellent contrivance for the purpofe which it is to ferve *.

Wheel-Ploughs.—The manner of conftructing thefe ploughs, like thofe of the fwing kind, varies confiderably in different places, according to the nature of foils and other circumftances; but in every form, and in all fituations, they probably require lefs fkill in the ploughman. Wheels feem, indeed, to have formed an addition to ploughs, in confequence of the want of experience in this clafs of men; and in all forts of foil, but more particularly in thofe which are of a ftony and ftubborn quality, they afford great affiftance to fuch ploughmen, enabling them to perform their work with greater regularity in refpect to depth, and with much more neatnefs in regard to equality of furface. From the friction caufed by the wheels they, however, give much greater refiftance, and confequently demand more ftrength in the team that is employed; and, befides, are more expenfive in their conftruction, and more liable to be put out of order, as well as more apt to be difturbed in their progrefs by clods, ftones, and other inequalities that may be on the furface of the ground, than thofe of the fwing kind.

It is alfo obferved by a late ingenious writer, who feems to have paid much attention to the invention and improvement of implements for the purpofes of hufbandry, "that with *wheel*-ploughs workmen are apt to fet the points of their fhares too low, fo as by their inclined direction to occafion a heavy preffure on the wheel, which muft proceed horizontally;" the effect of this ftruggle, he conceives, to be an increafed weight of draught, infinitely beyond what could be fuppofed: for which reafon, he thinks the wheel is to be confidered as of no importance *in fetting a plough for work*; but paffing lightly over the furface, it will be of material aid in breaking old leys, or ground where flints, rocks, or roots of trees occur,

* Young's View of the Agriculture of Suffolk.

and in correcting the depression of the shares from any sudden obstruction, as well as in bringing it quickly into work again, when thrown out towards the surface*.

But an able writer, in speaking of the agriculture of Middlesex, though by no means an advocate for wheel-ploughs, remarks, that "on a comparative view of the whole of any two extensive districts, whereof one is tilled with wheel-ploughs, and the other by swing ones, as Berkshire and Norfolk against Middlesex and Surrey, including every description of ploughmen usually met with in those counties, it has appeared to him, on many occasions, that for neatness of work wheel-ploughs have the advantage. This circumstance, and keeping the men in good temper, is, he thinks, probably of more consequence than a little disparagement in point of draught †."

Notwithstanding this, the objections which we have just mentioned, the weight of the carriages for the wheels, and the trouble of fixing and moving them, are inconveniences that operate strongly against the use of this kind of plough in all cases, but more particularly in those of general tillage.

An intelligent farmer in one of the midland districts, however, assures us, that the rotheram-plough, with one or sometimes two wheels fixed near to the end of the beam, without any carriage, goes very light, and is very useful; such alterations as are necessary requiring very little time or trouble. Where two wheels are employed, the plough does very well without a holder on a good tilth or light sward, except at the setting in and turning out.

Wheel-ploughs should, however, probably be seldom had recourse to by the experienced ploughman, though they may be more convenient and more manageable for those who are not perfectly informed in that important and useful art.

This sort of plough will, in general, be found most suitable for the more stiff tenacious soils, and those in which stones, flints, or other obstacles of the same kind abound, the most advantageous and desirable properties under such circumstances being those of strength, and of not being easily thrown out of the ground. For general purposes in such soils, perhaps the *Hertfordshire wheel-plough*, which has a piked share, may be the most suitable implement; but where the ground is very strong, and where very deep ploughing is required, the *Kentish turnwrist-plough*, with a chisel-pointed share, should probably be preferred.

On light, loamy, and friable soils, where deep ploughing is not necessary, the *Norfolk wheel-plough* will be found a convenient and useful tool, as being compact and light in its form, doing its work with neatness, and requiring only a small draught.

* See Communications to the Board of Agriculture, vol. II. p. 419.

† Middleton's View of the Agriculture of Middlesex.

The rotheram-plough, with a wheel as above, might probably, in many caſes, be made uſe of with equal, if not greater advantage, from its being very light and requiring little ſtrength in the team.

The improved *common wheel-plough*, and likewiſe the *two-wheel-plough*, are implements which will be found uſeful in certain kinds of ſoil where the more complex ones cannot be employed, as in breaking up freſh grounds, &c. The former has been lately much improved by the addition of an iron earth-board firmly ſcrewed to the coulter, which in ſome places is called a *flay*. It is made uſe of when ploughing turf, by which it is taken off and turned into the furrow, when the plough immediately covers it with earth. It is obſerved that, by this management, turf, at one ploughing, has the appearance of a fallow, and harrows nearly as well. A little more ſtrength in the team is however required *.

The latter has generally a check-chain, by which the wheel is pulled up, in order to be out of the way in opening ridges and clearing up furrows. There is alſo in ſome of the fen diſtricts a kind of *wheel-plough*, which has much reſemblance to the Dutch paring-plough employed in Cambridgeſhire, which is a good inſtrument for ploughing where there is much ſtubble, or where the want of proper management in the farmer has ſuffered twitch-graſs to become abundant. The mould-board in this plough has a good ſweep, and the ſhare a proper form, which ſhould be conſtantly kept ſharp by means of files, and be well ſteeled. The coulter in this ſort of plough is a ſteel wheel, which is well adapted for the purpoſes we have juſt mentioned. Mr. Young, in his account of the agriculture of Lincolnſhire, remarks, that Mr. Cartwright affixes to this plough a bean-drill of great ſimplicity, that drills upon the centre of the preceding furrow, while the next is turning; with which apparatus it muſt be a very convenient and uſeful implement for a variety of purpoſes in arable huſbandry.

The *double* or *two-furrow plough* is an implement that has not yet, perhaps, been fully tried in different kinds of ſoil; but which certainly, when well made, may, in many ſorts of land, be advantageouſly employed. It produces two furrows at once, and in ſome of the lighter ſorts of ſoil, has been found to perform its work in a tolerably neat manner. It requires, however, great power in the draught, eſpecially in ſtrong ſoils when dry and ſtony, and does not even in ſome caſes anſwer well. But for ploughing level ſandy lands into wide ridges it may, in general, be a good tool, though it is obviouſly more confined in its work than a ſingle plough. The chief and moſt important advantages attending its uſe are, in the ſaving of the attendance of one perſon, and in doing nearly double the work in the ſame length of time, with

* Pitt's View of the Agriculture of Staffordſhire.

but little more ſtrength in the team. Ploughs of this kind are made either with or without wheels. It is, however, obſerved by the inventor or improver of them, that thoſe which he has contrived, from the clean ſharpened conſtruction of the breaſt and throat, will be enabled to break up deep ſtiff land with infinite ſucceſs; in which caſe, the coulters ſhould, he ſays, be ſet nearly ſtraight with the throat and ſhares; but that in croſs-ploughing or ſtirring, they may be ſet three-fourths of an inch towards the land, by which greater diſpatch may be obtained in ſeed time. Should they carry too deep a furrow, the correction of their ſhares, he obſerves, is obvious; but if they hug too much to the land, or go unſteady to the ploughman, it muſt proceed from a want of ſetting them true, relatively to each other, and from an undue regulation of the cops, as in this a nice attention is required. It may ſuggeſt itſelf, he further remarks, that two-furrow-ploughs are unfit for hilly ground; but he thinks the very reverſe is the caſe. The effect, he ſays, of ploughing acroſs the inclined plain or hill, is that of carrying the ſoil in time to the bottom of the field, which muſt be carried bodily up again at a great expence: let ſuch land, ſays he, be therefore worked from top to bottom; one furrow being carried with the hindmoſt or land ſhare up the hill, and two down, ſo that the power may be apportioned to the weight with which it has to contend, and the needleſs toil to the team be ſaved. That power which was required to carry two furrows up, would be ſuperfluous in carrying the ſame down the hill; and the effect will be as three to four, or an acre and a half inſtead of two acres in a day. And as deep ploughing is not much required, except where the cultivation of tap-rooted plants are intended, he thinks that two-furrow-ploughs, though they ſhould be deemed incapable of carrying a deep furrow, which, he contends, is far from the truth, muſt come into admirable effect, as a twofold advantage can be taken of the ſeaſon in ſowing, and the buſineſs being done at half the expence. But where long uſage, and the convenience of conſtant road, confine perſons to teams of heavy corn-eating cart-horſes, theſe ploughs become objects of great importance; becauſe their teams will not, he conceives, feel the difference between their common ſingle-furrow working one acre, and the well-conſtructed two-furrow plough with two acres a-day. It is remarked in addition to this, that ſome of the midland counties, as Leiceſter and Stafford, have been greatly benefited, under theſe circumſtances, by the uſe of theſe ploughs, although they have not been ſo conſtructed in the throat and breaſt as to leſſen the means of reſiſtance. And obtuſity in theſe parts not only adds incalculably to the weight, but is liable to break the furrow, and thus ſpoil the work. It may likewiſe be obſerved, that removing reſiſtance, not only removes the labour

of the cattle, but is equally advantageous in increafing the ftrength of the implement.

It is ftill further remarked, that this fort of plough has lately been found ufeful in his own country, in even breaking up ley-ground, although formerly only in common ufe for fallowing, not being thought capable of ploughing leys, as, from their conftruction, requiring too great ftrength in the team; and that a premium has lately been given for this fort of plough, working ley-ground only. He ftates alfo, that one acre and an half of ley-ground was broken up by four oxen with great eafe to themfelves in three hours and fifty-five minutes, they having, as part of a conftant courfe of work, ploughed feventeen perches fhort of an acre of the fame kind of ground the fame morning: this was performed in order, he fays, *to prove the effect of moveable plates at the extremities of the mould-board*, that the furrows might be laid more or lefs flat; as mould-boards formed to lay furrows in ley, fo as to give the greateft quantity of mould or foil to harrows, cannot be of that fhape or form beft fuited to make good work in ftirring earths, more efpecially the laft, which ought to be thrown up in fmall feams, as it were, that the feed may be properly buried. For this purpofe it has, he afferts, hitherto been ufual to rip off the plate and drive in wedges, by which the mould-plate muft be liable to be injured; and from the trouble attending the operation, it has often been omitted, and confequently the land imperfectly worked. This inconvenience may, he fays, be remedied, and the mould-board be adjufted with great facility and expedition, by having the neceffary parts of the mould-board or plate cut off, and afterwards connected with the fixed parts of it by means of flat hinges, or of thin flexible plates of tempered fteel, or of hard hammered iron, fo as to admit of thefe parts being fet to have different inclinations with the fixed part of the mould-board. By means of two fcrews paffing from the infide through the lower parts of the handle of the plough, oppofite the back parts of thefe moveable pieces, they may be kept at any defired degree of inclination according to the nature of the work to be performed. As ley-grounds cannot be laid too flat, or feed earths too much on an edge, by this improvement in the mould-board of thefe ploughs he thinks it may be readily adjufted for either purpofe, as it may be rendered more flat or more convex, according to the circumftances of the cafe. That part of the mould-plate the moft liable to wear fhould be made of double the thicknefs of the others, in order to render it as durable as the reft of the plough.

The increafed weight of draught when thefe moveable plates were extended, did not appear, he obferves, on trial, in a two-furrow-plough, to be, by the cops, more than twelve pounds, in ley-ground at fix inches depth. The friction in fur-

rows required to be laid flat, was, it is faid, lefs than could have been fuppofed; probably in both furrows not more than from twelve to fix pounds*.

It is remarked by the fame author, in another work, that in order to qualify ploughs of this kind for broad work of every defcription, breaking up of leys not excepted, thefe plates are abfolutely requifite; and that in fingle ploughs they are almoft equally fo. The principle of this moveable plate, fays he, though it may not at firft catch the attention of every one, has found ftout advocates in ploughmen, as it faves their right arm much trouble in wedging and hammering mould-plates, and their right leg much exertion in attempting to tread flat the furrow which the plough had left on an edge†.

But, notwithftanding thefe ingenious and interefting obfervations, from the nature and conftruction of fuch ploughs, they muft obvioufly be much more limited in their application than fuch as are fingle; and under fome circumftances, as where the land is full of ftones and uneven, perhaps wholly inapplicable.

Where, however, the circumftances of the land are fuch that they can be introduced with any probability of advantage, they ought not to be overlooked, as being conducive, by their great difpatch of work, to economy in farming labour, which is certainly an object of much importance.

Skim-Coulter-Ploughs are a fort of ploughs that may often be employed with advantage on extenfive farms, where there are fuch kinds of lands as require them. Of thefe ploughs there are many different ones adapted to particular ufes and fituations; fuch as the *Trench-Plough*, which is fo contrived as to turn up the ground to a great depth, in foils of different kinds, where there is fufficient ftaple. It is an exceedingly ufeful implement in various cafes, as, by means of it, land may be opened to any depth in feparate horizontal flices, the weeds being thus cut off in the firft operation, while the next raifes a flice or portion of frefh mould from below the foil which afforded the former crop, and depofits it upon the rubbifh before turned down, by which means more abundant nourifhment is prepared for the crop that is to follow. For thefe purpofes, however, in all foils, a ftrong team muft be had; but only one fuch tillage is required for moft crops. From the flices of earth raifed by this plough, being placed one over another, the ground generally harrows well, and the growth of weeds is in a great meafure prevented. It is confequently evident, that, confidering the number of ploughings generally given in the ordinary way of preparing lands for

* Communications to the Board of Agriculture, vol. ii.

† Somerville's Syftem of the Board of Agriculture.

a crop of barley or turnips, and under the following syſtem for wheat, and the labour and expence in the latter caſe, of raking, picking, and burning weeds, that the advantages of the trench-plough muſt be greater than is, perhaps, generally ſuppoſed. There is alſo another conſideration of ſome importance in this ſyſtem of management, which is, that the ſtaple of the ſoil is increaſed in depth, and its parts ſo divided and looſened, that the fibres of the roots of the crop are more at liberty to range, and of courſe to take up their proper nouriſhment, which muſt render it more certain and of better quality. A plough of this kind, with a double ſhare, one placed directly over the other, has been much employed by ſome good cultivators in the ſouthern parts of the kingdom. By this means, one narrow ſhallow furrow may be taken off the ſurface, and another beneath it any moderate depth that may be required; and it will perform its buſineſs to ten inches in depth, as well as only five or ſix. It is an highly uſeful tool in putting in one crop immediately after another; a mode of cultivation which could not indeed be well practiſed without it. In this way rye, or other green crops, which have great height of ſtem, may be turned down without leaving any part of them ſticking out in the ſeams or crevices between the furrows; whatever is turned in being really covered, by which means the ſurface is of courſe perfectly free from weeds, and clean for the ſucceeding crop of whatever kind it may be*.

The *Miner* is another plough, which is uſed for opening ground to a great depth; it is made very ſtrong, but with a ſhare only, not having any mould-board; it therefore rather looſens than turns up the earth. In deep ſtiff ſoils, where the ſurface mould is good, it may be conveniently employed in the ſame furrow after a common plough, in order to ſtir the ground to a greater depth. It is in uſe in ſome of the northern counties; and Doctor Anderſon mentions it as an implement that all farmers who have land ſuitable for it ſhould have in their poſſeſſion. It is an extremely uſeful tool where working deep is neceſſary without bringing up the inert under ſtratum or ſub-ſoil, as in looſening the ground for carrots, or other tap-rooted plants, and in eradicating the roots of thiſtles or other weeds which ſtrike deep in the earth.

The *Paring-Plough* is a neceſſary inſtrument where the practice of paring and burning is much required, as in bringing into cultivation heath, moor, and other waſte lands. It is conſtructed in ſuch a manner that the ſurface of the ground can be cut off to any depth, which is an advantage that can ſcarcely be obtained by any other means.

* Annals of Agriculture, vol. x. p. 190.

The *Double-Mould-Board-Plough* is a kind of plough that may ſometimes be employed with advantage in making furrows, and ſetting potatoes, cabbages, and other ſimilar crops, and in earthing up thoſe and other vegatables that are planted in rows. The ſame purpoſe may, however, frequently be anſwered by a plough of a leſs expenſive and leſs complex kind.

In the ſurface-draining of land, different ſorts of ploughs are in uſe in different places, according to the difference of the ſoils, and the objects of the farmer.

The *Common Draining-Plough*, which is employed in ſome of the midland counties, for the more general purpoſes, is a good, and not very expenſive, tool. And the *Mole-Plough*, invented by Mr. Adam Scott, and as improved and made uſe of in the midland counties, is likewiſe an implement of this kind, which, in ſuitable ſoils and ſituations, as in pleaſure-grounds, and where much regard is had to the ſurface-appearance of the land, may be of conſiderable benefit in forming temporary drains. It makes a drain without opening the ſurface any more than merely for the paſſage of a thin coulter, the mark of which ſoon diſappears. This inſtrument is chiefly employed in ſuch graſs-lands as have a declination of ſurface, and where there are not many obſtructions to contend with; but it may be uſed in other kinds of land, as on turnip-grounds that are too wet for the ſheep to feed them off, or where on account of the wetneſs the ſeed cannot be put into the earth. With this plough the drains ſhould be made at the diſtance of ten or fifteen feet in ſtraight lines, and all ſo contrived as to diſcharge themſelves into one large open furrow, or grip, at the bottom of the field. As it requires great ſtrength to draw this implement, it can only be uſed where a good team is kept. It is ſuggeſted by a very intelligent practical agricultor, that in deep clayey ſoils it may be highly uſeful, but that where there are beds of gravel or ſand intervening, it cannot be employed with advantage.

The *Draining-Furrow-Plough* is another plough of this claſs, which may be employed for making large open furrows, by which the water may be taken off from the ſurface of the land. It will frequently be found a neceſſary tool in thoſe clayey ſoils where water ſtagnates on the ſurface of the ground, and which cannot be removed by the more general modes of under-draining.

The *Marking-Plough* is an uſeful inſtrument for the purpoſe of ſtraightening, as well as regulating the diſtance of ridges, where the practice of drilling is in uſe.

The *Single Hoe-Plough* is likewiſe an implement which, from the great ſimplicity of its conſtruction, may be of much utility in ſtirring the mould in the intervals of grain, or other crops, and laying it to the roots of the plants, thereby deſtroying and preventing the growth of weeds. The mould-board in this plough is ſo contrived that

it can be raifed or depreffed according to the nature of the crop, and the intention with which it is employed.

Drill-Machines.

In the conftruction of all implements of this fort the greateft attention fhould be paid to have them as fimple in their mechanifm as poffible, in order that they may be ufed without difficulty, by thofe who have but little knowledge of the nature of fuch machinery: much care fhould alfo be taken to have them fo made, as that they may perform their work with correctnefs; that the feeds, of whatever kind, may be delivered and depofited in the ground with the greateft evennefs and regularity; and that they may not be bruifed or injured in any way during the operation; as the want of proper attention to thefe particulars feems to have confiderably retarded the progrefs of the drill fyftem of cultivation.

Various implements of this fort are in ufe in different parts of the ifland, which are contrived for the purpofe of ftirring the earth, and drilling different kinds of grain and feeds at the fame time; but in the choice of fuch tools the farmer fhould be chiefly directed by the fituation of his ground, the nature of the foil, and the kinds of grain which he intends to cultivate. In general, however, the more fimple the conftruction of fuch inftruments, the better they perform their work: one and the fame fort of drill cannot, however, anfwer on farms of large and fmall extent; they fhould, therefore, be adapted to the fize of the farm, as well as the nature of the foil and crop that is to be cultivated.

The machine which was propofed and made ufe of by the ingenious and intelligent improver of the drill hufbandry, feems to have been by no means well adapted to the purpofes of the fyftem, and on that account probably contributed to retard the progrefs of the art. It neither few the feed in fufficient quantity, or with fufficient accuracy, though its general principle appears to have been fufficiently clear and fimple, from its having become the model of many fubfequent implements of the fame kind. A late ingenious author has recommended many interefting and ufeful improvements in this machine, fuch as enlarging that part of the axle-tree which delivers the grain into a cylinder of fome inches in diameter, with excavations in the rim, which rim rifes above the corn in the feed-box, and lets drop again into the feed-box whatever grains fill the holes above the level of the rim, as that fide of the cylinder afcends. By thefe ingenious contrivances the quantity of feed delivered is rendered uniform, and none of the grain is in the way of being crufhed or otherwife injured. The whole machine thus becomes fimple in its conftruction, and of no great expence, which are circumftances of the greateft importance in fuch machines.

The great ſimplicity of this improved machine conſiſts, the author obſerves, firſt, in its having only a ſeed-box, and not both a hopper and ſeed-box as in ſome others, as that of Mr. Cook ; ſecondly, in the flues which conduct the ſeed from the bottom of the ſeed-box into the drill-furrows not being disjoined in the middle, in order to permit the lower part to move to the right or the left, when the horſe deviates from the line in which the coulters paſs, as in Mr. Cook's machine, which in this is performed by a ſimple univerſal joint ; thirdly, in the horns or ſhafts behind, between which the perſon goes who regulates the coulters, being equally fixed to the coulter-beam and the axle-tree, while in others, as that we have juſt mentioned, they are all of them moveable joints, like a parallel rule for the purpoſe of counteracting the ſwerving of the horſe, which is here done by a ſimple univerſal joint ; fourthly, in altering the dimenſions of the holes in the axis of the ſeed-box, by ſimply turning a ſcrew, ſo as to adapt them to all kinds of ſeeds which are uſually ſown on field lands ; fifthly, in the ſtrong bruſh of briſtles which ſweep over the excavations of the cylinders beneath the ſeed-box, ſtrickling them with ſuch exactneſs that no ſupernumerary ſeeds eſcape, and that none of them be the leaſt broken or injured, which is the caſe in other machines, as the original one of Mr. Tull ; and laſtly, in its greater ſimplicity rendering it leſs expenſive in its conſtruction, and leſs liable to be out of repair, as well as the management of it more readily and more eaſily underſtood *.

In the ſame ingenious and philoſophical work the author alſo deſcribes a ſeed-box, the invention of Mr. Swanwick, of Derby, by which the ſeed may be depoſited with ſtill greater accuracy. This box is forty-eight inches long within ; which ſpace is divided into ſix cells, for the purpoſe of ſowing ſix rows of ſeed at the ſame time, as in that juſt deſcribed ; and at the bottom of each is a hole for the ſeed to paſs through into the ſeed-flues, but without any revolving axis, a wooden bar about four feet eight inches long, and three-eighths of an inch in thickneſs, through which there are ſix perforations, each of them exactly one inch long, and half an inch wide, and three-eighths of an inch deep, which is the thickneſs of the bar that ſupplies its place. The centres of theſe holes are exactly eight inches diſtant from each other, correſpondent to the holes at the bottom of the ſeed-box, over which it is made to ſlide backwards and forwards in a groove. In this ſliding motion it paſſes under ſtiff bruſhes, which are placed over it on each end of the holes, at the bottom of the ſeed-box, and ſtrickle off the grain as the holes in the ſliding bar paſs under them, by which the quantity of ſeed is meaſured out with a conſiderable de-

* Phytologia, p. 608.

gree of accuracy. And in order to increafe or diminifh the quantity of grain delivered, the flider is covered with a cafe of tin, which has fix perforations, exactly correfponding with the holes in the flider; but inftead of the bit of tin being cut out the whole length of the hole, part of it is left at one end equal to the thicknefs of the flider, and is bent down after the flider is put into the cafe, in the fame manner as the tin cylinder in the above machine. This cafe is moveable about an inch backwards and forwards by turning the finger-fcrew, and thus the holes are made larger or fmaller in order to fuit various forts of grain, or different quantities of the fame fort. The flider is moved forwards by a bent iron pin which is attached to it, and which paffes into a ferpentine groove fixed to the nave of the wheel, and backwards by a fteel fpring at the other end of the feed-box. It is obferved that the fimplicity of the flider at the bottom of the feed-box in this inftrument may be, in fome refpects, greater than that of the wooden and tin cylinders in the former one, as this has but fix holes to meafure out the feed, while the other has twenty-four; but that, perhaps, in other refpects it is lefs fo, as in this there are twelve brufhes, one on each fide of each of the fix holes, whereas in the former only fix brufhes rub upon the tin cylinder. It is probable too, that as the reciprocating motion of this flider muft be quick, as it muft act once every time the periphery of the wheel of the carriage has paffed nine inches forwards, it may not be fo eafy to execute as the cog wheel and uninterrupted movement of the axis and cylinder in the preceding drill*.

A machine of this kind, invented by Mr. Amos, and defcribed in his treatife on drill hufbandry, is faid to be a good, cheap, and convenient tool. Grain, feeds, and pulfe of all forts, are afferted to be eafily fown by this inftrument on every defcription of land, in any quantity, and at fuch depths and diftances as may be required. It is conftructed with fpherical cups and fows, at a great variety of different diftances, both in refpect to the rows and the intervals, performing its bufinefs with much difpatch and little ftrength of draught †. The drill part of the machine may be fixed to the beam of any common plough. There are, however, feveral other implements of the fame kind made by different perfons, which have been found to perform equally well.

Mr. Cook's improved *Drill* is a well-conftructed inftrument, and on certain light foils is found to anfwer perfectly; but on others it is faid to be liable to deliver the grain with fome inequality. An intelligent agricultor, who has had much experience of it, however, remarks, that it is an implement which will depofit any

* Phytologia, p. 609. † Amos on Drill Hufbandry.

quantity of feed on the acre, at any required depth, with intervals of eight, nine, eleven, or eighteen inches, and at two, three, or four feet width, with confiderable exactnefs; and that wherever it fails of fuccefs, he fuppofes, it muft proceed from the want of proper attention in the perfon who makes ufe of it. With him it has been found ufeful upon all foils, except fuch as are ftony or rocky, and he thinks it may be employed with equal advantage on ftrong clays and clayey loams, as on thofe of the lighter kind. This drill is conftructed fomewhat on the fame principle of that which has been juft mentioned, and is certainly capable of pretty general application. One invented and employed by Mr. Ducket is alfo fimple in its nature, and likewife faid to be capable of being managed with great eafe, by an ordinary workman.

A machine of this kind, which the Kentifh farmers find very convenient for drilling wheat, barley, oats, peas, tares, and various other crops, is made by Mr. Wellard, of Deal. It is drawn by two horfes a-breaft in a double pair of fhafts, and drills feven rows at a time, feven inches apart. From the peculiarity of its conftruction, any quantity of grain required per acre can be drilled, and from its great fimplicity it is not liable to be put out of order. It cofts about fourteen guineas.

Turnip-Drill.—An ufeful inftrument of this fort has been contrived by Mr. Bailey, for fowing turnips on the tops of one-bout ridges. In this implement the defects of fowing too much or too little feed are obviated. It confifts of a folid cylinder, made of iron or brafs, about two inches in diameter and one inch broad, on the furface of which are formed fifteen or fixteen cavities refembling the form of a femi-egg when cut longitudinally, and as deep as to hold four or five feeds each. On the back of the cylinder, a little from the top, is placed the hind part of the hopper, to which is fixed a piece of iron or brafs one inch long and half an inch broad, hollowed on the infide into the form of a Gothic arch, the fides of which meeting the fides of the cavities in an oblique angle, prevent the feeds from being bruifed : at the lower end of this piece of iron, or gatherer, there is a flit three-tenths of an inch long and one-tenth wide ; and at the back of it, a thin flat piece of iron moves up and down by means of a fcrew at the top of the hopper, which enlarges or leffens the orifice directly above the cavities, and increafes or diminifhes the quantity of feed delivered, as the operator may think proper. This flip of iron, or regulator, is let into a groove made in the board which forms the back part of the hopper.

The cylinder is fixed before the cavities are made, on an iron axle one inch fquare, turned very true, as well as thofe parts of the axle which turn in the collars fixed in the handles. To the ends of the axle, two wheels, twenty-fix inches in diameter, are fixed, which turn the axle and cylinder round, and which in

paſſing through the hopper containing the ſeed, bring forward in each cavity a number of ſeeds and drop them into the ſpout, by which means they are conveyed to the coulter, which forms a channel on the top of the one-bout ridge in order to receive them.

If the cavities in this drill be made to hold five ſeeds when the regulator is ſcrewed cloſe down, and there be ſixteen of them, it will depoſit eighty ſeeds each revolution; and from the diameter of the wheel being twenty-ſix inches, and the circumference eighty-one inches and a half, eighty ſeed will be ſown in eighty-one and a half inches, or nearly twelve in a foot. This being the *minimum* quantity, by ſcrewing up the regulator the number may be increaſed gradually to fifty or ſixty in a foot; which is far more than is neceſſary, except in particularly unfavourable ſituations.

Another *Drill* conſtructed by the ſame gentleman for ſowing all kinds of grain, in any quantity, and at any diſtance, ſeems likewiſe to have conſiderable merit. The inſide part of it, by which the quantity of ſeed is regulated, is an iron axle one or one and one-fourth of an inch ſquare; upon which are fixed, at nine or ten inches diſtance, five or ſix or more braſs fluted cylinders, the flutes being rather more than a ſemicircle five-eighths of an inch in diameter, or five-eighths wide and ſix-eighths in depth. To theſe are fitted hollow cylindrical rims of hammered iron, which have ſegments turned down at right angles, to form exactly to the flutes of the braſs cylinders; the cavities of which are increaſed or diminiſhed by the ſegments of the iron cylindrical rims ſliding backwards and forwards in the flutes. This is performed in all the cylinders at the ſame time, by a rectangular ſpace being made in the braſs cylinders, through which paſſes a ſtraight piece of iron moving on friction-wheels, and faſtened to the plates, and alſo the cylindrical rims. A lever moved by a ſcrew paſſes through the frame; one end of which is forked, and made to fit exactly the ſides of the collar or plates of iron. By turning the ſcrew the lever moves the whole of the rims at once, and the cavities are increaſed or diminiſhed at pleaſure, and almoſt inſtantaneouſly, even while the machine is going and at work, ſo as to ſow all ſorts of grain and in any proportion.

When *Turnips* are to be drilled, the large hopper is taken off, and a ſet of ſmall ones fixed upon the half-egg cavities at the end of the braſs cylinders, and the quantity of ſeed regulated as in the turnip-drill juſt deſcribed.

For ſowing beans and peas at wide intervals, as from twenty-ſeven to thirty inches, Mr. Bailey makes uſe of a drill with only one wheel and one cylinder, which a man wheels before him in the furrow: or a method which he finds better, is, to fix it in the body of a ſmall plough drawn by one horſe, with one ſtilt that

paſſes between the wheel and ſeed-box. By this means the wheel moves on a ſmooth ſurface between the land ſide and mould-board, and the ſeed is depoſited at a regular depth. For beans he finds two inches to anſwer very well. By means of the ſame plough he has ſown both wheat and barley at different intervals from ſix to twelves inches, and one and a half or two inches deep, with good ſucceſs; and for ſmall concerns, he thinks that this cheap and ſimple apparatus will be found very eligible and advantageous.

The drill is fixed to the plough by two pieces of iron going from the ends of it, one to the beam and the other to the ſtilt; which moving round on bolts, allow the wheel to fall and riſe with every accidental hollow or eminence. The lower part of the coulter is kneed or bent to bring it to the ſame plane with the land ſide of the plough.

The *Drill-Barrow* is an inſtrument contrived with much ſimplicity, and well adapted for ſowing ſome grains and ſmall ſeeds, as it can be readily regulated in reſpect to the proportion of the ſeed. It, however, ſows only one row at a time, which in many inſtances is inconvenient. This machine would be much improved if it were made to drill ſeveral rows at once, and capable of being regulated in reſpect to diſtances for the ſeed. In ſome places this drill is much eſteemed for putting in bean crops, in doing which it delivers into the furrow.

HOES.

Of this kind of tools there have been a great number invented at different times both for the purpoſe of being drawn by horſes, and uſed with the hand. Mr. Cook's improved horſe-hoe is unqueſtionably a good implement for hoeing crops at certain diſtances; but for narrow irregular diſtances the expanding horſe-hoe, contrived by Mr. Amos, is probably a preferable inſtrument, as its moveable ſhares render it capable of being regulated to different ſpaces, according as the crops may have been drilled with greater or leſs intervals. It will be found moſt uſeful on light friable ſoils, and where the ground is in a mellow condition. This hoe is conſtantly made uſe of by ſome good farmers in Lincolnſhire for beans, cabbages, potatoes, and ſuch-like crops, and found to be very effective *.

M'Daugals's *improved Hoe* is conſtructed on a ſimple principle, and anſwers the various purpoſes of a hand-hoe with great eaſe and convenience, eſpecially where the grain or pulſe has been ſown in equidiſtant intervals. The wheel in this in-

* Young's Survey of Lincolnſhire.

ftrument fhould, however, be made folid, as the open wheel is liable to clog and fill up when the ground is foft and wet.

But in mellow foils, and where hand-hoeing is practifed, the implements of this kind which have been invented by Mr. Ducket are probably more ufeful; as from their being heavier in the iron work, and having fhorter handles than thofe in common ufe, they would feem to be more effective. Hoes in fome refpects fimilar to thefe have long been in ufe for hoeing the ftrong land of the vineyards in Portugal *.

But notwithftanding thefe inftruments, the bufinefs of hoeing may frequently be well performed on ftiff foils, and where the diftances of the crops are pretty wide, with any common fmall plough that has a broad fharp fhare. With thofe inftruments the workman can go to what depth and as near the rows as he pleafes. It has been obferved, and probably with truth, by a late writer, that he can find nothing equal to a "plough for the purpofe of cleaning land and earthing the crops. He has tried," he fays, "double-moulded or double-breafted ploughs to earth up the rows, but that they will not at all do in drill hufbandry, as you cannot humour them to the width of the rows, which are fometimes a little wider or narrower; and if they vary but an inch or two, it deftroys the effect intended, as the mould cannot be regularly raifed, and the corn will be in fome places high, in fome low. A common plough will perform this work to perfection; the expence amounts to not more that one fhilling per acre, and the fervice rendered the crop is worth a pound at leaft, exclufive of the advantage of cleaning the land better than by any other means; for when you fee a weed you may," he fays, "with a common plough go fufficiently deep, or give it what direction you pleafe."

And in fpeaking of this kind of tools he further remarks, that as fuch weeds as ftrike with a tap-root are not eafily cut by the fcarifier when it happens to be blunt, but are often dragged down and left growing, he has invented an inftrument fuperior to the plough or fcarifier for the purpofe. "It is made," he fays, "of a triangular form, with a beam, and two fmall wheels under the beam to run before it, in the fame manner as in the Norfolk plough. There are three coulters, with a fhare rivetted under each of them, made fharp at the point like a fleam, and about fourteen inches wide. The coulters penetrate under the mould as deep as the plough, and, without moving the earth much, cut up thiftle, brackens, &c. better than any inftrument he has yet met with. Where fuch weeds are very numerous, he ufes a beam with one wheel, into which he puts one of the coulters, to cut between

* Communications to the Board of Agriculture, vol. II. and Somerville's Syftem of the Board of Agriculture.

the rows of the drills: it will penetrate any depth required. The one with three fhares will, with a pair of horfes, do as much work in one day as three ploughs." It is however obferved, that this machine will work only upon light land where the fallow is well broken and nearly clean of twitch. Where kitlocks grow it will alfo, he thinks, be found very ufeful; and it is of fuch a fimple conftruction that any perfon may make it *.

SCARIFIERS AND *SCUFFLERS.*

THESE are inftruments which are in a great meafure fimilar to that juft defcribed, and which feem daily to be coming into more general ufe for the purpofe of clearing and rendering arable land fuitable for the reception of the feed, as well as for fcarifying and ftirring the earth between the rows of drilled crops. They are likewife fometimes made ufe of for clearing ftubble after the crop has been taken off, but for which they are not probably good tools. They are made of various forms and conftructions, and have commonly a great number of iron plates or feet, the edges of which are well fteeled and kept fharp. Thefe are moftly fixed to the ends of an equal number of iron bars forming a kind of legs. Some of thefe tools are alfo made with wheels, and others without them; the latter fort anfwer equally well for many ufes, and are much lefs expenfive. A pair of handles are generally fixed on behind, by which the implements are worked, and, by the difference in the degrees of preffure, are regulated in refpect to depth at the pleafure of the perfon who has the management of them. The feet fhould have a fort of triangular fhape, each of the fides of which may be about fix inches in length. They fhould be fo contrived as to cut up the roots of weeds at a good depth, and not be eafily thrown out of the ground by fuch obftructions as they may occafionally meet with. They may be ufed with different numbers of tines or teeth, according to the difference of intention with which they are employed, and in proportion as the land is clean or foul, loofe or tenacious. The implements of this kind which are made by Mr. Cook are very good ones; and others, contrived with great fimplicity, are defcribed in many of the reports publifhed by the Board of Agriculture.

The main object of thefe inftruments is, that of leffening the ufe of the plough; and in certain fituations and foils they may, without doubt, be employed with more advantage to pulverize the earth and clear the lands from weeds. Lands which have been once ploughed over, in preparation for barley or turnips, may be

* Experienced Farmer, vol. II. p. 86.

eafily rendered clean and fine by them, and the ufual fubfequent harrowings and ploughings be made unneceffary. As the implement of this kind which has been defcribed above, cannot, as the inventor affures us, be employed except where the ground is light, and " where the fallow is well broken, and nearly clean of twitch*," it may be objected to on that account. But there is, befides this, another objection to this fort of tools, which is that of their being liable to clog much when the land is wet, an inconvenience which confiderably leffens their general application. In the conftruction of the improved *Scuffler* employed in fome of the midland diftricts this inconvenience has however been attended to, and in a great meafure corrected. The wheels in this inftrument are made a foot and a half in diameter, and the length of the hoes two feet, having a flight curve. It is alfo fo contrived, that it may be drawn by two horfes abreaft, or at length, as may be found moft proper and convenient.

The *Extirpator* is a machine of this fort which feems to be ufed with advantage in fome parts of Suffolk, as well as other counties, for deftroying weeds, and clearing fuch lands as have been once ploughed for the reception of the feed. It is drawn by two or more horfes, according as the foil is more or lefs heavy and tenacious, and as the depth required is greater or lefs. It does much work in a little time. When employed, it may be fixed to the wheels of a common wheel-plough, and be regulated in refpect to depth in the fame manner.

If the land has been once ploughed over and laid a fummer fallow, the common way of proceeding with this inftrument is to work it over twice with it; the firft time about two inches deep, and the fecond croffways about four inches in depth; which, by afterwards running a common harrow over it, renders it proper for the drill or fowing. Lands ploughed in Autumn, and intended for fpring crops, may alfo be well prepared for the feed by this inftrument.

The fhares in this tool are commonly made about nine inches long, and nearly of the fame breadth, being attached to a kind ftem or fhank of ten inches in length, at the diftance of about twelve inches. It has ledges before and behind; the firft of which is about five and a half inches long, and the latter fix feet in length, both having the fquare of four inches: the diftance of thefe ledges from each other is generally about twelve inches. The beam is feven feet in length, having the elevation of about three feet. It has likewife two handles behind.

It is faid to anfwer on all lands, and to be capable of being managed by almoft any ploughman. How far the expeditious way of preparing ground by this tool

* Experienced Farmer, vol. II.

may be effectual, must however be shewn by more general and extensive trials than have probably yet been made with it.

The *Cultivator* is another tool calculated for the same purposes; the invention of Mr. Cook, to whose ingenuity the cultivators of land are greatly indebted. It consists of a diagonal beam, in which are placed a number of narrow shares; and when employed in this way is in many places termed a tillage scarifier, but when used with broad triangular shares it has the title of scuffler. The whole, when complete, forms the cultivator.

All these kinds of implements may be considered as in some degree appendages to the drill, and may frequently be applied to the same wheels. In comparison with the plough they seem, however, instruments of very limited use, yet in different instances they may be necessary and convenient in the management of arable land.

DRAGS.

These are tools of a somewhat similar kind, and employed both for the purposes of clearing land and preparing it for putting in the seed. They are made with considerable difference in different parts of the kingdom. The common drag is most generally made use of, but the duck-footed one, with four rows of teeth, is preferable in many cases, as it does its work more effectually. A late writer recommends an instrument of this kind, in which the teeth are fixed in by wedges instead of screws, so that they can be put in and taken out readily, and be set to any depth, as a very useful tool *.

Implements of this sort are commonly made of a triangular form, being about seven feet in width behind, and having thirteen or fourteen teeth in each of their sides, set in such directions as to cross each other, being fastened at top either by screws or some other convenient means. Where such implements are made use of occasionally as scarifiers, the teeth should be wedged in somewhat in the manner of coulters, and a proper set must be had for the purpose.

HARROWS.

Implements of this sort are not only useful, but particularly necessary, in the practice of husbandry, both for covering the seed and preparing the land for its

* Experienced Farmer.

reception, though they have yet undergone but little improvement; the chief circumftances in which they have been rendered more convenient are in the pofition and mode of fixing in the teeth, the direction of the bulls, and the manner in which the horfes are attached to the implements. It muft be evident to every one the leaft converfant with the bufinefs of harrowing, that no one harrow, whatever its conftruction may be, can be fuitable for every fort of foil, or can act with equal effect on fuch grounds as are rough and fmooth, or firm and loofe; they muft be adapted to the nature of the land and the particular purpofes the operator has in view *. In the lighter forts of ground, a light harrow with fhort tines or teeth may be fufficient; but in ftrong and tenacious foils, or fuch as have been newly broken up from the ftate of old leys, or from a ftate of nature, fuch as moors and waftes, a harrow which poffeffes much greater weight and has longer teeth is to be preferred; and even where the land is rough and not eafily reduced, as in fallowing ftrong clays, two harrows faftened together may frequently be neceffary, in order to fully reduce and break down the cloddy foil. For thefe purpofes, too, it is better, efpecially where the land is tenacious and abounds with the roots of weeds, that the harrow fhould not be too thickly fet with teeth; as in fuch circumftances, where it has a number of teeth, it is not only foon choaked up and prevented from working, but confined too much to the furface, by which the foil is very imperfectly reduced and broken down.

In performing the bufinefs of harrowing, much time is often loft in turning at the ends of the ridges, where two or more common harrows chained together are employed, by their hitching on each other, or turning over, and requiring the driver to ftop in order to put them right again. To remedy this inconvenience, harrows have been contrived with running bulls, a mode of conftruction which has been found to anfwer well. This inconvenience may however be corrected in a much eafier and lefs expenfive way, as by faftening the inftruments to each other by means of proper hooks and eyes, or what are termed coupling irons in fome places, by which contrivance the different harrows rife and fall at the fame time, and are kept from ever getting upon each other. The pofition of the teeth, fo that they do not move in the fame line of direction, is likewife an object that has been attempted to be effected in different methods; but the moft fimple and expeditious is probably that of having the harrow fo formed, as to be fome inches narrower before than behind, and at the fame time to be capable of being fet to different widths, fo that the diftance between the teeth may be regulated by increafing or

* Gentleman Farmer, p. 19

diminiſhing the difference between the fore and the hind parts of the harrow. Common harrows may likewiſe in ſome meaſure be prevented from having their teeth moving in the ſame directions, by being ſo yoked or attached to the horſe as to move on the land ſomewhat in a diagonal line *. In the conſtruction of all the larger ſorts of harrows, it is of the utmoſt importance that the tines, or teeth, have a ſlight inclination forwards, and in all kinds of theſe implements that no two of them move exactly in the ſame line of direction. By theſe improvements, harrows are capable of doing a great deal more work, of keeping more cloſely to the ground, and of cutting as well as tearing up more effectually ſuch weeds as they meet with.

It is a good practice to have the teeth, at leaſt of large harrows, faſtened into the bulls by means of nuts and ſcrews, in ſuch a way as that they can be removed with facility when neceſſary; or, perhaps, a ſtill better method is to have the heads of the teeth made ſquare, and put upwards into the bulls, having long holes in the parts that come above them, into which ſquare wedges may be put in order to keep them faſt and prevent their being loſt.

Harrows are alſo ſometimes conſtructed with teeth of unequal lengths. The firſt row of tines, for inſtance, being a quarter or half an inch ſhorter than the ſecond, and ſo on. Theſe harrows have been ſaid to do more work, and to be more readily cleanſed of weeds and other ſubſtances, by which they are liable to be choaked up. Harrows, formed in this way, are common in ſome parts of Devonſhire, and have lately been introduced into Leiceſterſhire with ſucceſs by Mr. Hanford. This kind of implement is made in different ways, and with different number of bars or bulls, but from three to five is the moſt common, and the quantity of teeth vary in the ſame manner.

The *Brake-Harrow*, the *Double-Harrow*, and the improved *Common Harrow*, are all of them good tools when applied under proper management: a harrow invented by Mr. Graburn, and repreſented in the Report of the Agriculture of Lincolnſhire, ſeems alſo to poſſeſs conſiderable merit, eſpecially for lands in which the ridges are narrow and round.

There is a Harrow deſigned by Mr. Knight, which is likewiſe well contrived for obviating the difficulty and inconvenience of turning, as well as leſſening the draught of the horſes, as it is conſtructed with wheels; but it would ſeem to be much too complex and expenſive in its conſtruction for general uſe. In many

* Robertſon's General View of the Agriculture of the County of Perth.

kinds of land it muſt alſo be extremely liable to be prevented from working by the wheels being clogged and filled up. For putting graſs ſeeds into the ground, a ſmall light harrow, with ſhort teeth, is moſtly to be preferred.

A *Buſh-Harrow*, or that ſort of harrow which is formed by the interweaving of ſome ſort of buſh-wood into a kind of frame made for the purpoſe, and raiſed in the fore part by two ſmall wheels, may frequently be employed for the ſame uſe, as well as for harrowing in dung, or other earthy matters, into graſs lands.

Harrowing, in general, is by much the beſt performed by driving the horſe or horſes by whip reins of ſufficient length to permit the perſon employed to walk after the harrows. By this management he can clear the harrows as occaſion may require, and proceed in his buſineſs with greater diſpatch. It is now a pretty general obſervation among the intelligent cultivators of land, that the buſineſs of harrowing is more effectually and more advantageouſly performed by ſingle-horſe harrows, than by ſuch as require two horſes. In the attachment of theſe implements to the power which is to draw them, the common method is by a ſtrong ſort of ſtaple fixed to one of the corners of the harrow by a bolt; but a mode which appears more advantageous, is that of connecting the muzzle with a perpendicular pin at one corner of them *.

ROLLERS.

THESE are moſt commonly made of wood, caſt-iron, or ſtone, according as one or other ſort of material is moſt ready and eaſy to be obtained; and are of different ſizes and weights, in order to ſuit different purpoſes. In conſtructing heavy rollers, the workman ſhould be careful that they have not too great a diameter, whatever the material be of which they are formed, as the preſſure is diminiſhed where the implement is of very large ſize, by its reſting on too much ſurface at once, except an addition of weight in proportion be made. By having the roller made ſmall, when loaded to the ſame weight, a much greater effect will be produced, and a conſiderable ſaving of expence be made in the conſtruction of the implement. All the larger ſorts of rollers ſhould have double ſhafts, in order that they may be drawn by two horſes abreaſt; and ſuch as are employed for arable lands ſhould have a ſcraper attached to them. This addition ſaves much time, and prevents the driver the trouble of conſtantly ſcraping the machine, eſpecially in wet ſeaſons, and clayey tenacious lands. Strong frames are alſo neceſſary for rollers, ſo that proper weights may be put upon them; and open boxes or carts placed upon them may ſometimes be requiſite, in order to contain any additional weight that may be thought

* Agricultural Report of Perthſhire.

proper, as well as to receive ftones or other matters that may be picked up from the ground. Pieces of wood or ftone, as heavy as a man can lift, are the moft fuitable fubftances for loading thefe implements with, where they have not the advantage of boxes.

The *Common Rollers*, fuch as are moftly ufed for rolling wheat in the fpring, and grafs feeds, are generally about five or fix feet long, and from fifteen to thirty inches in diameter; but thofe employed for flattening one-bout ridges, in order to prepare them for drilling turnips upon, are commonly fhorter and of much lefs diameter.

Spike-Roller.—This kind of implement is formed pretty much in the fame manner as the common roller, except in having the addition of a confiderable number of fpikes made to it. Thefe rollers are principally employed where the foil is ftiff and cloddy, in order to reduce and break down the lumpinefs, and bring the land into a fine ftate; and when well conftructed are, in many cafes, good and effective tools for the purpofe.

Drill-Roller.—The Norfolk farmers, we believe, have the merit of this invention. It is formed with rings of caft-iron, round that part which conftitutes the roller, at fmall diftances from each other; by which means drills are made in the land, and the intermediate parts rifing into ridges, the corn of courfe chiefly falls into them, being thereby better depofited in the earth, and better covered than it would have been if fown upon the furrows without them. The main object of this practice is the faving the expence of dibbling, though it is not by any means fo good a practice. On light grounds, where preffure is required, it may, however, be employed with great advantage. It may alfo be made ufe of in dry feafons for reducing ftiff clayey lands which are under fallow; for which purpofe it is, perhaps, a more efficient implement than the fpike-roller. Where this roller is made ufe of, the feed is fown broad-caft, and covered by means of a fmall or bufh harrow. The wooden rollers which are frequently, and with great propriety, had recourfe to, for rendering grafs and pafture lands fmooth and even, are in many places much too large to produce the powerful effect they are intended to have, without a proportionate increafe of weight was added, for the reafons which have been juft given. They fhould therefore be made lefs in fize, and be loaded, in order to produce the great degree of preffure which is wanted in thefe cafes.

As in turning at the ends of ridges or fields, rollers, from their not moving upon their axis, but being drawn along the furface of the ground, are liable to tear it up, and make deep holes and depreffions before they come again into the direct line of draught, and are not brought round without great exertion in the team; it has been attempted, in order to obviate thefe inconveniences, to conftruct rollers in two pieces, and by the divifion in the middle to

enable the different parts to twift round on their proper axis, one forward and the other in a retrograde direction. When formed in this way, the cylinders are beft when made of caft-iron.

In the rolling of ground, efpecially when fuch rollers are employed as are compofed of one piece only, it is by much the beft method, where it can be accomplifhed, to go round the whole field in fomewhat a fpiral direction, and by that means keep continually proceeding without the neceffity of making fhort turns; and in rolling down grafs feeds with corn crops, this mode is in general to be preferred: but grafs-lands may be rolled in any direction, though the mode of rolling ridges feparately is evidently more troublefome than that of croffing them.

THRASHING-MACHINES.

The thrafhing of corn, by means of machinery, has been long in ufe in the northern diftricts of the kingdom, and mills of this fort are now becoming general in moft parts of the country; and upon arable farms of confiderable extent they cannot but be highly advantageous, as they fave much labour and expence. In the making of thofe machines, attention fhould always be had to the fize of the farms, or rather the quantity of grain that may be grown on them, and the mill proportioned accordingly. They are moftly conftructed on the principles of the flax-mill, and are moved either by water or horfes, the firft by far the beft method where it can be had; the grain by thefe machines being, as it were, fwingled out of the ears by means of beaters which are attached to a cylinder that moves with very great velocity. Since the introduction of thefe machines, many improvements have been made on them; a fcreen has been added for the grain to pafs through into a winnowing-machine, and a circular rake to remove the ftraw from it; as before this addition the ftraw was forced out from the beater upon the upper barn floor, and required much time and labour in fhaking and putting into order, which by this contrivance is faved. In working thefe mills, four perfons are commonly neceffary; one takes the fheaf from the ftack, another places it ready for the third who is to feed the mill, and the fourth removes the ftraw to prevent its collecting in too large a quantity. It has been objected to thefe machines, that they do not thrafh fome forts of grain clean; this has been particularly the cafe with barley. It is, however, obferved by an intelligent writer, that the circumftance on which the good thrafhing of this kind of grain depends, is the iron covering under which the beating wheel, having fix beaters, moves: in fome machines this is fixed, while the beating wheel is capable of being raifed or depreffed at pleafure; but a recent improvement is to render the

iron roof moveable, and the wheel fixed; and the iron is placed ſo near to the beaters that the grain is rubbed, as well as ſtricken out of the ear*. In ſome machines of this ſort, the beaters are a little rounded; but it is probably a better practice to have them of the common flat form.

In ſome large mills of this kind the rollers take in about three hundred inches of grain in a minute. The medium length of the ſtraw being eſtimated at about thirty inches, and ſuppoſing half a ſheaf to be introduced into the machine at a time, the whole ſheaf will be equal to ſixty inches, and the machine when ſupplied with a middling quantity of water will thraſh five ſheaves in a minute. But in reſpect to the performance of theſe mills much muſt depend on the attention with which they are fed, as a ſmall neglect in this point will make a very conſiderable difference in the quantity of work done.

An excellent deſcription of a mill of this nature is given in a late publication, in which it is remarked, that in ſuch mills five people are commonly neceſſary to keep the work going on without embarraſſment; but that this depends greatly on the conſtruction of the machine, ſome of them being ſo contrived, that the work can be performed with much fewer hands. The manner in which theſe people are employed is this: One finds conſtant work in carrying the ſheaves to the man who feeds or puts the unthraſhed corn into the machine, and in looſing the bands; another is required to feed the machine; a third to carry off the ſtraw; the fourth to attend the fanners, and lay aſide the cleaned grain; and a fifth, where horſes are made uſe of, to take care that they go regularly; and that by means of five men and four horſes they will thraſh at the rate of five quarters in the hour on a medium, and when the crop is rich, and eaſily thraſhed, conſiderably more: conſequently if a thraſhing-mill was to be employed for a whole day, or nine hours, it would thraſh forty-five quarters; but in that caſe it would be neceſſary to employ two ſets of horſes. The expence is calculated in this manner:

	£.	s.	d.
Hire of eight horſes, at 2*s.* 6*d.* each per day, . . .	1	0	0
Five men's wages, at 1*s.* 6*d.* each, ...	0	7	6
	£.1	7	6

In this account the hire of the men and horſes are, it is conceived, charged at the higheſt rate, and that the expence of thraſhing forty-five quarters of grain would coſt 1l. 7s. 6d. or about 7d. each quarter. But that taking the average expence of

* Young's View of the Agriculture of the County of Lincoln.

thraſhing forty-five quarters of grain with the flail, throughout the whole kingdom, including an equal proportion of all kinds, cannot be, it is ſuppoſed, eſtimated at leſs than 3l. 7s. 6d. or 1s. 6d. each quarter, which makes a difference of about 11d. each quarter. It is alſo farther obſerved, that ſince the introduction of theſe mills, the grain is thraſhed by the ordinary ſervants on the farm, and without in any material degree obſtructing the operations in the field; farmers in general employing their men and horſes in this buſineſs in bad weather, when other operations cannot be carried on.

The whole expence of conſtructing a thraſhing-mill, including the building of the ſhed for covering the great wheel, does not, in almoſt any caſe, exceed 100l. The ordinary annual repairs may, one year with another, amount to 5l., which added to the intereſt of the prime coſt, makes the yearly expence 10l.; a ſum for which any quantity of grain, however great, that may be ſuppoſed to grow on one farm, can be thraſhed, and that too in a manner much ſuperior to what can be done by manual labour. The expence either of erecting theſe machines, or of keeping them afterwards in repair, muſt be conſidered by every intelligent occupier of a corn-farm as a ſecondary object, when compared with the advantages that are derived from them; ſuch as the performing of the operation at leſs than half the ordinary price, and affording the farmer the means of ſecuring his grain from being embezzled: beſides, the ſaving, in regard to ſuperior clean thraſhing, as has been now well aſcertained, is not only more than the annual expence of repairs, but ſo great as, on a farm of conſiderable extent, to reimburſe the farmer for the whole of his expenditure in the courſe of a few years. Therefore, conſidering the increaſing ſcarcity of labourers, and the recent great advance in the rate of labour in all the better cultivated parts of the kingdom, the introduction of thraſhing-mills into common uſe cannot but be highly beneficial.

There is, however, one difficulty in the introduction of thraſhing-mills into the ſouthern parts of the kingdom, which ariſes from the manner of harveſting all kinds of grain, except wheat, which cannot probably be eaſily removed; as the corn, in order to be clean thraſhed, ſhould be put into the machine as ſtraight and regular as poſſible. For while the ſheaves, after being looſened and ſpread on the board, ſo as to be eaſily taken in by the feeding rollers, are paſſing between them, they keep the ſtraw ſteady, by which means the ſtrokes of the beaters or ſcutchers operate with more force and effect in ſeparating the grain from the ears; whereas, if the unthraſhed corn goes in ſideways or irregularly, the thraſhers can have but little power upon it. This would no doubt frequently happen in thraſhing corn which has been mowed with the ſcythe, and which is harveſted in every reſpect like hay, ſo that unleſs the

unthrashed grain be put into the mill in small quantities, it is almost impossible that it can be completely separated from the straw*.

But though, when the size of the machine is considerable, the expence of erecting it may be from eighty to one hundred pounds, according to situation and materials, smaller ones may be erected at much less, as from thirty to fifty pounds.

Some of these kind of mills have rollers or small mill-stones added to them, for the purpose of crushing and grinding grain for horses, swine, and other animals; and also instruments for cutting straw into chaff.

On the necessity of employing machines of this kind, it is remarked by an able writer, that it is the only method left for having the corn cleanly and properly thrashed. They are so quick in the work, that the whole may be done under the eye of the master, and the corn secured in the granary without the least pilfering. The saving, by this means of thrashing, in the extra quantity of corn procured, and the security against having the corn stolen in the chaff, it is asserted, amounts to an advantage in favour of the mills of about ten per cent on the corn crops; in some cases, to one shilling a bushel on wheat, and very generally to twenty shillings an acre on the wheat crops †.

This machine has undoubtedly many advantages over the flail, as well as those of saving time and hands; as in thrashing damp corn, not capable of being fully accomplished in any other way, especially in wet seasons; and with smutty wheat, which is thrashed by it without any mischief being done to the sound grain, the smut not being crushed comes out whole, and is blown away with the chaff.

The principal objections that have been made to these machines, are the great expence of erecting and using them, their tendency to diminish the labour of the poor, and their affording too great a supply of straw at a time. These objections are, however, of little consequence, when the general utility and advantages of such machines are considered; besides the latter are either such as have nothing to be apprehended from them, or as may be readily obviated. The difficulty in regard to the straw may be easily removed, by having it properly stacked up or cut into chaff.

WINNOWING-MACHINES.

Machines of this sort are in pretty general use, where thrashing mills, to which they may be attached, are not erected: they are made on different principles according-

* Donaldson's Modern Agriculture.

† Middleton's Report of the Agriculture of Middlesex.

ing to particular circumftances. Thofe contrived by Mr. Cor, of Leicefter, on Mr. Winlow's plan, are good implements, and will drefs grain with much difpatch. And there are others which are employed in the northern diftricts, which are made by Rodgers, that are alfo upon good and convenient principles: as well as many more in different places which have great merit in their conftruction, and do their work well and expeditioufly. They are made of different prices, from three to five or fix pounds, and will laft many years when the materials of which they are formed are of a proper kind.

CHAFF-CUTTERS.

Of thefe ufeful implements there are a great variety formed on very different principles. There feems, however, in general, to have been too little attention paid to their conftruction, as there is fcarcely one fo cheap as to be fuited for general ufe. Thofe made on Mr. Cook's and Mr. Nailor's plans are in much efteem in many places; but one lately conftructed by the fucceffors of Mr. Winlow and other manufacturers, in which the ftraw is regularly brought forward by an iron cylinder contrived for the purpofe, as the implement is turned round, and cut by means of three knives fixed on the wheel, would feem to be more convenient. Straw may, however, be well and expeditioufly cut by almoft any of thefe implements; but in many diftricts, from their great expence, the common cutting-box is ftill in ufe.

As the principal objects aimed at in this fort of machine are thofe of expedition, and the leffening of labour, it is obvious that many of the improved inftruments of this kind muft anfwer thefe purpofes much more effectually than thofe that were formerly in ufe, efpecially where they are attached to any great power, fuch as that of horfes or water, as in the cafe of thrafhing-machines, or other mills, for which they are in common adapted.

RAKES.

Implements of this kind are employed for different purpofes in practical hufbandry.

The common *Hay-Rake* is too well known to require any defcription; but a late improvement upon it feems to deferve notice. This is the making of the teeth to fcrew into the heads, and faften with fcrew nuts, by which the danger and inconvenience of their dropping out is prevented.

With thefe *Spring-teeth-Rakes* one perfon is faid to do confiderably more work than with the common wood rakes; and they are made ufe of both for hay and

corn with great eafe and convenience. Rakes are conftructed in this way, and fold by Mr. Cort of Leicefter.

The *Corn-Rake* is a large rake made ufe of in many diftricts for raking together the grain after it has been mown. It is fometimes made with wooden teeth, feven or eight inches in length; but as thefe are very apt to break, it is a much better method to have them of iron, in which cafe they fhould be a little bent forward. As it requires great exertion in ufing thefe rakes, they fhould be conftructed in as light a manner as is confiftent with the work they have to perform.

The *Twitch-Rake* is a fort of rake which is frequently neceffary for the clearing of certain defcriptions of land from thefe, as well as other kinds of weeds. The beft way of making it is probably with a double row of teeth, thofe of one row being placed oppofite the intervals of thofe of the other. By this means it is rendered a more convenient and effectual implement.

The *Horfe Stubble-Rake* is a large heavy kind of rake, with ftrong iron teeth, fourteen or fifteen inches in length, placed at five or fix inches diftance from each other, having a beam about four inches fquare, and eight or ten feet in length. It is commonly drawn by two horfes, and is very effective in clearing ftubbles.

Wheel Carriages for Hufbandry.

The *Waggons* which are employed in hufbandry are conftructed in different forms, and of various dimenfions, in different diftricts; and, in general, without fufficient attention to the nature of the roads, or the materials that are to be carried. They are indeed commonly much too heavy and clumfy to be convenient. The Berkfhire waggon would feem, however, to be conftructed on a more neat and convenient principle than thofe which are made ufe of in moft of the more fouthern counties: it is neither fo heavy nor fo high, while it poffeffes fufficient ftrength, and is eafy in the draught.

A very ufeful improvement in this carriage has been fuggefted in a late publication, which is that of leaving the fpace fufficiently deep in the bed of the waggon for the fore wheels to lock round in the fhorteft curve, as by the prefent mode of conftruction much time is loft in turning at the ends of fwaths in carrying hay, and on many other occafions. In this way the inconvenience may be removed without doing the fmalleft injury to the fymmetry or ftrength of the carriage *. But thofe employed in Gloucefterfhire are preferred to any others in the kingdom, by an

* Agricultural Survey of Berkfhire.

intelligent writer, who has attended much to the fubject; as by means of a crooked fide-rail, bending archwife over the hind wheel, the bodies or frames of them are kept low, without the diameter of the wheels being much leffened. The bodies are likewife made wide in proportion to their fhallownefs, and the wheels run fix inches wider than thofe of moft other waggons, whereby advantages in carrying top-loads are evidently obtained *.

In many diftricts, waggons are the principal carriages employed in getting in the hay and corn, and carrying them to the market, and likewife in bringing manure, coals, and various other materials. In fuch cafes they are generally drawn by the whole team on the farm, and two men, or a man and a boy, are neceffary to attend them in performing the bufinefs.

But this fort of conveyance, however well conftructed, from its great weight and unwieldinefs, as well as its expence, feems far from being advantageous to the interefts of the farmer; as while it is highly deftructive of the roads, it requires great power in the draught, which muft be procured at much expence, without affording an adequate compenfation in the quantity of materials which it conveys. It is however fuppofed by a later author, that in performing diftant carriages, where the roads are level and fubftantially made, and the waggons at all times *fully loaded*, one of them may probably be as advantageoufly ufed as two or more carts of lefs dimenfions; but that where labour is required to be performed with expedition, as in the harvefting of hay and corn, fuch unwieldy machines are ill calculated for the purpofe; and that on every occafion, where they return only half or a third part loaded, the farmer muft obvioufly fuftain a confiderable lofs †.

The ufe of heavy carriages being found inconvenient in performing fome forts of bufinefs, farmers, in particular inftances, have had recourfe to a lighter fort of vehicle for conveying manures, and other materials of the fame kind, upon land, while large waggons are employed for other purpofes. In this way the improved *Irifh car* has been made ufe of, and found well adapted to the conveyance of fuch fubftances, a good horfe being capable of drawing with eafe and expedition more than a ton weight.

In its conftruction it approaches much to the fquare form, being only a few inches longer in the bed than it is broad; the wheels are made low and broad, with a flat bearing, and placed under the body of the machine. From thefe different circumftances it poffeffes many advantages; it can be readily filled, pafs confined gateways with facility, and be drawn upon foft meadow or ploughed grounds with much lefs injury and inconvenience. From the cylindrical form of the rims of

* Marfhall's Rural Economy of Gloucefterfhire.

† Donaldfon's Modern Agriculture.

the wheels much less resistance is said to be given in the draught *; consequently heavier weights can be drawn. The business of husbandry in Ireland is chiefly performed by this sort of small carts where hay or corn in the straw is to be carried, ladders being added. They are, however, thought inferior to the single-horse cart by some persons who have closely attended to them †.

CARTS.

THE *Carts* used in agriculture are made with much variety in different districts, but, like waggons, are probably, in general, too heavy in their construction to be employed with the greatest advantage. In some places they are so formed as to be, when empty, full as heavy as one horse can draw, especially where the wheels are broad, and of course much resistance occasioned by the increased friction. Nothing can, indeed, be more injudicious than the enormous bulk and clumsiness of the farm carts commonly employed in some districts; and the inconvenience and loss that result from the use of such clumsy carriages are greater than can be easily imagined. Besides, in consequence of the great height of the wheels, the nave, spokes, and fellies, must all be made of such weighty materials, in order to render them moderately strong and firm, as not only to add a prodigious unnecessary load to the horses, but greatly to enhance the expence of such vehicles. The difficulty of loading the cart, too, is so much increased from the same cause, as at least to double the expence that it might be performed at. And, on account of the number of horses that are required to draw them, and the time lost by the men in filling them, as well as the damage done upon retentive subsoils by their being torn into deep ruts, they are clearly shewn to be less advantageous than those of the smaller kind. Lightness in a carriage that is to go upon land, is a quality of the first importance in the business of a farm; this is particularly evident when it is considered that by such means, with the same strength of draught, more than four times the quantity of work can be done in the same length of time. Low wheels in vehicles of this sort also enable a much heavier load to be drawn; and of course render small carts preferable on that ground as well as those that have been stated. Carts, if properly constructed, for many kinds of weighty goods need not, independent of wheels and axle-tree, weigh more than one hundred weight, and for most purposes they need not exceed two hundred weight. Large waggons, as well as heavy-constructed carts, should, therefore, except in particular situations, be exchanged for those

* Cummings's Paper in Communications to the Board of Agriculture, vol. II.

† Annals of Agriculture, vol. XVIII.

of the lighter kinds, by which more work may be performed in an equal length of time, and with much greater ease and convenience.

Single-Horse Carts.—The large wains, or heavy four-horse waggons, which are common in many of the southern counties, are not only reprobated, but in a great measure exploded in those of the north, where one and two horse carts, with some variety of construction, are mostly made use of. One horse with these carts draws from twelve to twenty-four hundred weight, and on good road sometimes thirty, with great facility. In the most improved cart of this sort, the bottom, when placed on the axle, projects, on each side, over the inner heads of the naves, so as nearly to touch the spokes of the wheels; from which acquisition of breadth the capacity of the cart is much increased, while the side standards, by being brought nearer to the perpendicular situation, are enabled to sustain considerably more weight. This is termed the *Close* or *Coup Cart*, and is about five feet three inches in length, four feet in breadth below, and four feet three inches above, having a depth of one foot three inches, and containing about a cubic yard. The wheels are commonly about fifty inches in height, and the axle-tree mostly formed of iron, though wood will answer the purpose tolerably well.

A very intelligent agriculturist, who has paid much attention to the importance of carts in husbandry, found in constructing single-horse ones that the capacity of waggons was by no means a just rule for them. From those with which he was acquainted, containing in the bed, or *buck*, ninety-six cubical feet, being twelve feet long, four feet wide, and two feet in depth; it was supposed that to give one horse the fourth of the load of four, it would only be necessary to give them a space of twenty-four cubical feet, or to make them four feet by three, with a depth of two feet; but it was soon observed that the power of a horse was so much greater in working singly than in a team, that they might be enlarged so as to have the dimensions of five feet one inch in length of *buck*, three feet seven inches in breadth, two feet in depth, and to contain thirty-five cubical feet and a fraction. This places in a striking point of view the advantage such small carts have over large ones in the quantity of work performed *.

On the subject of single-horse carts it is also observed by another practical writer, "that those which are in use in various parts of England appear to be the best calculated for the purpose of carrying all kinds of goods, except single trees, blocks of stone, or any other article whose weight may be too much for the strength of such carts, and which cannot easily and without loss be divided into separate loads; in all or most places where the roads are particularly bad, either arising from soft

* Annals of Agriculture, vol. XVIII.

mud and clay, or large ftones, and where there are deep ruts, efpecially in hilly countries, and where the people are poor, and confequently particularly ftudious to keep their expences under as much as poffible.—Thefe are the places * and the people with whom fingle-horfe carts are in common ufe; and is a ftrong proof of the economy of the plan." " It is equally certain," he obferves, "that where the country is level, the roads free from ruts, and the people rich, they indulge in expenfive horfes, and in teams of parade and fhow. Such, for inftance, as thofe ufed by the brewers and diftillers of Middlefex and Surrey." It is alfo farther ftated, that he has four of thefe one-horfe carts in ufe himfelf; and that in loading the gravel of flints they are always filled to carry twenty-five cubical feet, and for manure from thirty to forty †. The great fuperiority of thefe carts is rendered ftill more obvious and ftriking by the obfervations that " two horfes, yoked in fingle-horfe carts, will draw as much as three horfes yoked in one cart; that a common carrier at Carlifle who many years employed a waggon, has laid it afide, and now ufes fingle-horfe carts only; as he finds he can, by that means, carry much greater weights ‡."

It is likewife fuppofed in the fame work, that the fuperior goodnefs of the roads in Cumberland may be afcribed to the general ufe of fingle-horfe carts; and that wherever waggons are employed they are the deftruction of roads, efpecially where the country is hilly, and where they are under the neceffity of having the wheels locked, as in fuch cafes the banks are in a manner ploughed up by them. The fame objections are equally ftrong againft large and heavy carts, as they produce the fame bad effects only in a fomewhat lefs degree.

It is, in fhort, ftrongly contended that waggons cannot be advantageous to the farmer, fince the fame number of horfes yoked in fingle-horfe carts will draw confiderably more than when yoked fix or eight together. Befides, it is conceived that fingle-horfe carts are fuperior on other grounds; they are loaded and unloaded with greater eafe and convenience, and are more handy for almoft every purpofe, and fix or eight of them may be managed by a man and a boy at very little expence.

In thefe carts too, the fize of the wheels can be adapted with the greateft exactnefs to the height of the horfes, and be placed with more convenience in regard to the centre of gravity of the load, by which the draught is confiderably leffened.

* The mountainous diftricts of Derbyfhire, Wales, Cumberland, Dumfries, Dumbarton, &c. &c.

† Agricultural Report of Middlefex.

‡ Agricultural Survey of the County of Cumberland.

In fact the Cumberland farmers, and those of some other counties, are fully convinced that very great advantages are derived from using carts of the single-horse kind. This sort of cart has likewise been compared in many different points of view by an accurate observer, and found in almost every instance to be greatly superior to waggons, or tumbrils, for almost all the various purposes of the farm *.

Where small carts are employed, it is frequently the custom to have different sorts for different purposes; those of the close kind being principally employed in carrying out dung, compost, and such-like compact heavy materials; while others made of a kind of frame-work are occasionally placed on the same wheels, and used for conveying bulky loads, such as corn in the straw, hay, and other similar substances, and which are in consequence denominated *corn* and *hay* carts. But the small cart, which is termed *farmer's-cart*, as well as most of the small-sized carts, and all those of the larger kinds, by having ladders attached to them at the ends and sides, may be conveniently employed for all the purposes of the farmer, without the trouble, inconvenience, and expence, of such a number of different sorts of carts.

A very convenient and useful form of cart for almost all farming purposes, especially in hilly districts, is in use in some parts of Wales, as about Llandillo; it is commonly drawn by three horses, one in the shafts, and two abreast before. The wheels are so made and placed, that the weight principally lies on the perpendicular spoke; the body of the carriage is short and rather broad, but made with such a curve as to give the load an inclination towards the axle-tree. This cart serves different uses; the body conveying dung, coals, &c. while by the addition of shelvings in the way just noticed the different crops can be carried with great facility.

When carts are intended for the quarry, and consequently carrying very heavy weights of solid materials, such as broad flat stones, slates, &c. they should be made low and without ledges, in order that they may be loaded and unloaded with care and convenience, and be sufficiently strong to prevent their giving way under the pressure of such loads.

Some ingenious improvements have lately been made in carts, in order to prevent the too great rapidity of their motion in going down steep hills, and for adjusting the positions of the centre of gravity of the load, so as to have a suitable bearing on the horse, or other animal, which draws them in such cases. The first has been effected by means of friction on the sides of the wheel, by the application of what is termed a friction-drag, instead of the usual inconvenient and dangerous method of locking the wheels: and the latter by a kind of toothed rack fastened to

* Young's Annals of Agriculture, vol. XVIII.

the front of the cart by a fcrew, and worked by a pinion and handle fixed to the pole, where the cart is made to be drawn in that way; and fo contrived as to admit of the fore part of the cart being elevated in proportion to the fteepnefs of the declivity, by which means the weight of the load is thrown more upon the axis, and confequently relieves the necks of the cattle which are employed in the draught. Another more fimple method of accomplifhing this point is by a ftrong piece of iron, which is bent fo as to form part of the arch of a circle, the radius of which is nearly equal to its diftance from the axis of the cart, and which is perforated with holes, for the admiffion of a ftrong iron-pin, by which the body of the cart is kept at any defired inclination with the pole.

The friction-bar, or drag, by being connected with the tail of the cart by a fmall chain, and to the front by a clofely notched or toothed rack that catches on a ftrong ftaple, can be made to afford different degrees of preffure on the fides of the wheel, according to the nature of the hill, or the inclination of the driver *. From the circumftance of this application of the drag, it has been termed a *drag-cart*.

By thefe ingenious and fimple contrivances many advantages are produced, the danger to which horfes and drivers are frequently expofed is obviated, much time faved, and the deftruction of the roads confiderably leffened.

As it has been fhewn that thofe parts of the neck and fhoulder-blades on which the collars reft in draught-horfes have that degree of flope, or inclination, which forms an angle with the horizon of about fourteen or fifteen degrees, it is plain that the line in which they draw fhould form the fame angle; as in that cafe they will pull in that line of direction which coincides the moft with the fhape of their fhoulders, and, of courfe, all the different parts of their fhoulders will be equally preffed or acted upon by the collars. Hence horfes draw more in conformity to their mechanifm in a floping, than an horizontal line of direction; and the power or advantage which they have in overcoming the refiftance of obftacles in this direction is likewife *mechanically* great, as may be eafily demonftrated. On thefe principles, therefore, fingle-horfe carts muft be more advantageous than teams, as in the latter cafes many of the horfes muft draw in a horizontal direction, confequently in a way that is inconfiftent with their mechanifm, and the eftablifhed principles of mechanical fcience †. This likewife places in the moft clear and fatisfactory point of view, the neceffity of having the wheels in all forts of carts properly adapted to the fize of the horfes or other animals employed in them.

* Lord Somerville's Paper in Communications to the Board of Agriculture, vol. II.

† Walker's Syftem of Familiar Philofophy, p. 167.

But notwithftanding the evident advantage of employing fingle-horfe carts in many diftricts in preference to waggons and heavy carts, it is obvious, from the nature of the roads and grounds, as well as many other circumftances in other places, that they cannot be generally had recourfe to; but that in refpect to the conftruction of them, as well as to moft other implements made ufe of by the hufbandman, there muft be a difference according to the nature of the fituation and the lands and roads on which they are to be employed. It muft, however, be admitted, that in moft of thofe diftricts in which a number of horfes are put into one cart, confiderable advantages may be derived from a reduction in their weight, and from their being made in a lefs clumfy manner, as well as from the rims of the wheels being made cylindrical inftead of the ufual conical form.

† Cummings's Paper in Communications to the Board of Agriculture, vol. II.

Fig. 1.

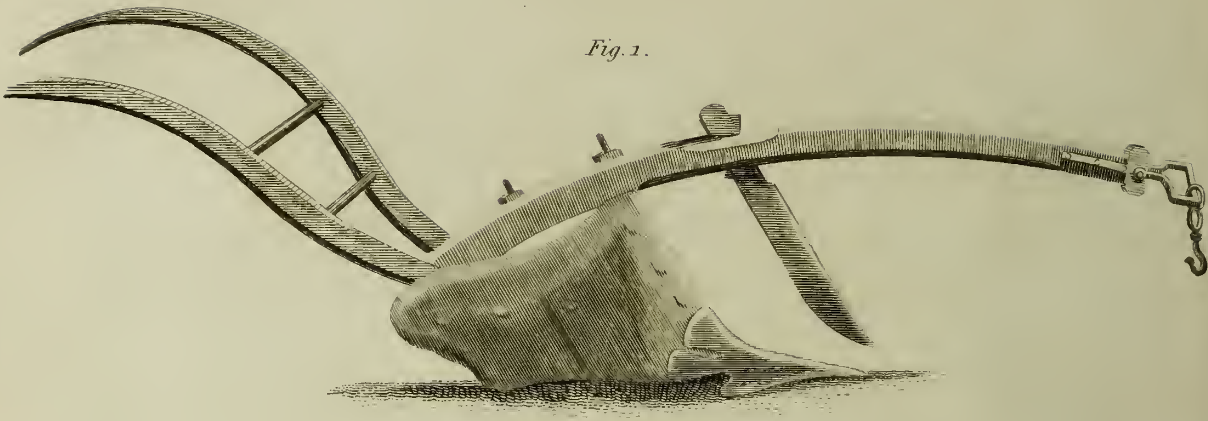


Fig. 2.

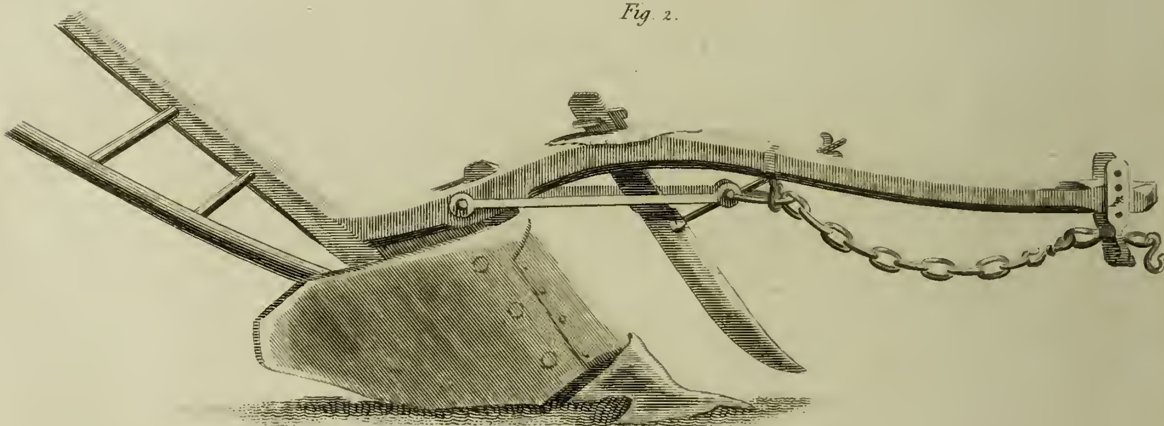


Fig. 3.

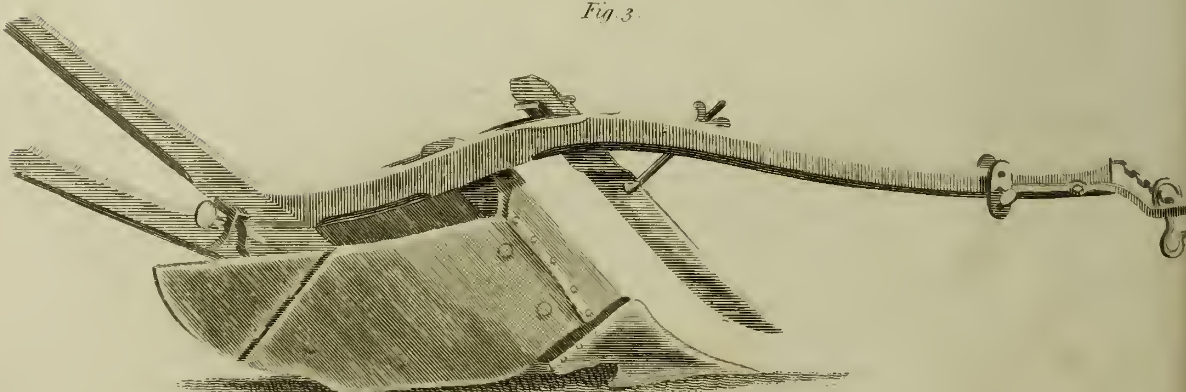


PLATE II.

Swing-Ploughs.

[*To face Page* 40.]

Fig. 1. Is a reprefentation of the Rotheram, or patent plough. As this fort of plough is not incumbered with wheels, it muft be the moft free from friction, and the refiftance which neceffarily proceeds from that caufe; confequently, may in general be faid to be the lighteft of draught.

Fig. 2. Reprefents Small's chain-plough, which will be found highly ufeful in cultivating ftrong lands and rough grounds; for, fhould the fhare, or coulter, fuddenly meet with any obftruction, the ftrain would be immediately thrown upon the chain, inftead of the beam.

Fig. 3. Is a fwing-plough, with Lord Somerville's improved mould-board.

From the clean fharpened conftruction of the breaft and throat of this plough, deep ftiff land may be broken up with great fuccefs; and as the extremity of the mould-board is moveable, the furrows may be laid more or lefs flat, according to the circumftances of the cafe.

KENTISH AND NORFOLK PLOUGHS.

Fig. 1.

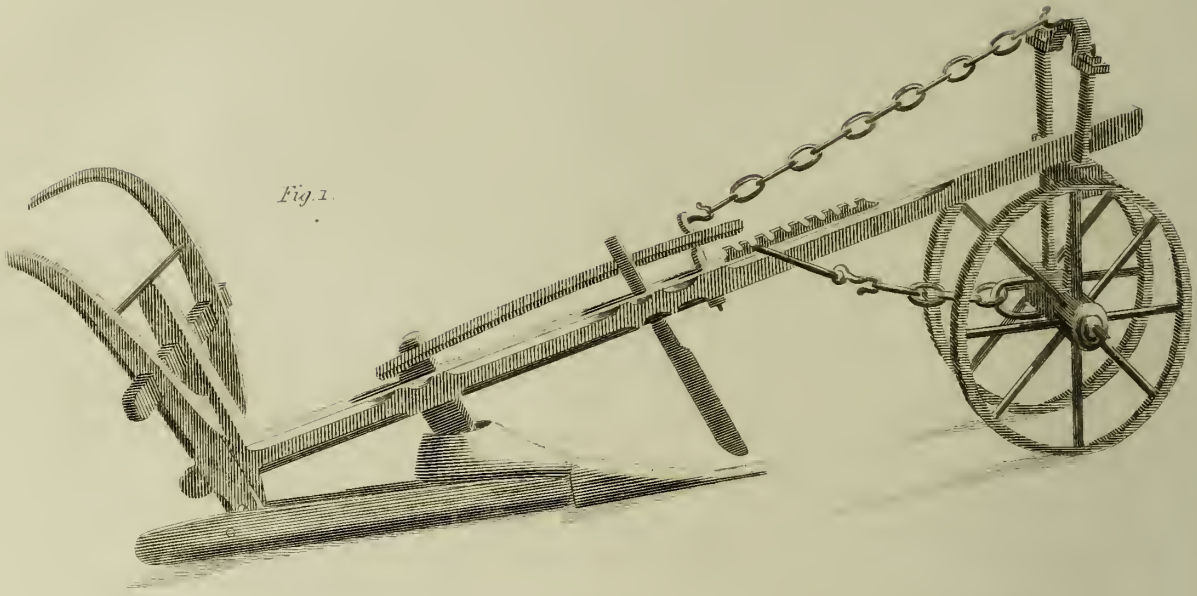


Fig. 2.

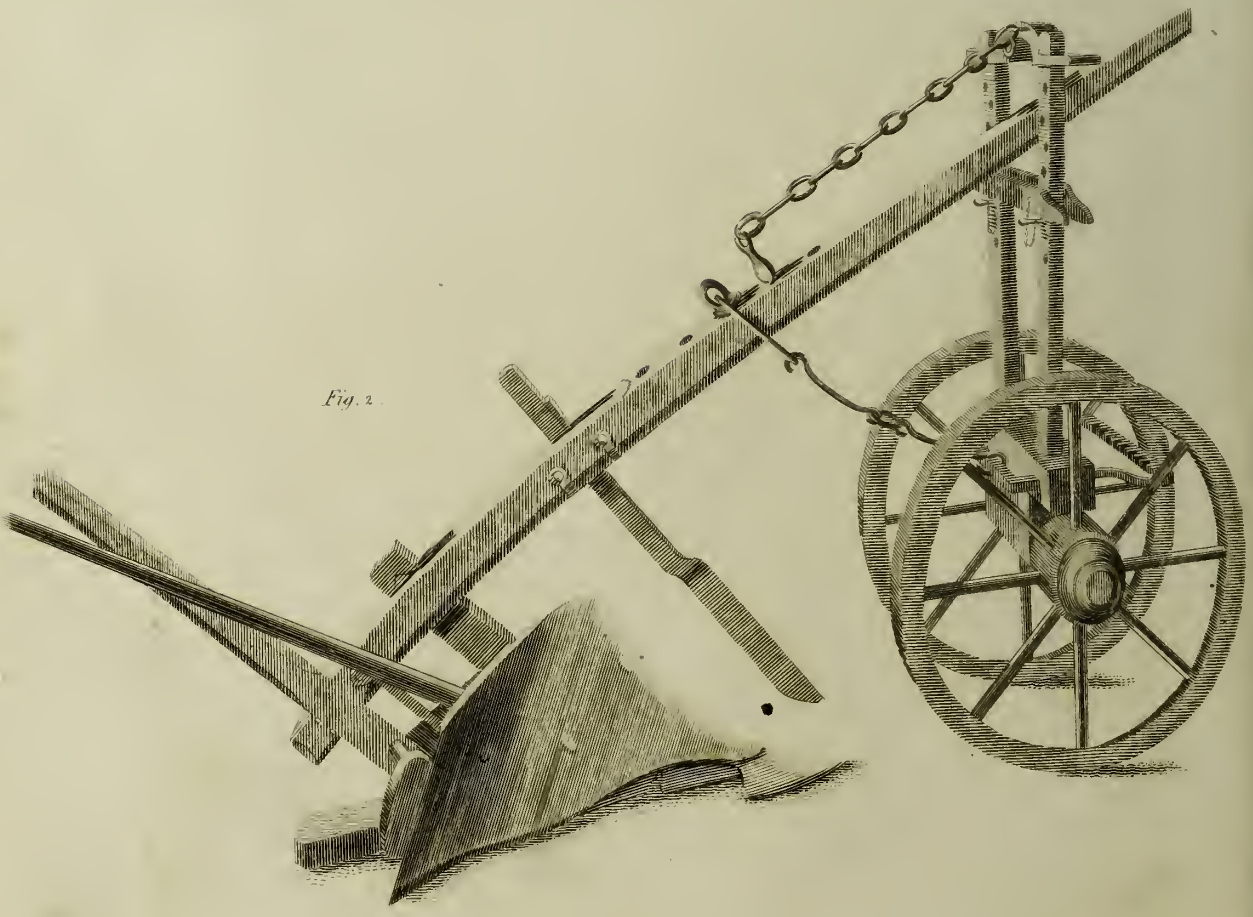


PLATE III.

Kentiſh and Norfolk Ploughs.

[*To face Page* 40.]

A repreſentation of the *Norfolk Plough* is given at *fig.* 1. The head and beam are ſhort, but carriage part or wheels ſtand high; by which means the fore end of the beam is much raiſed, and the horſes are more conveniently driven. It is uſually drawn by two horſes abreaſt, the ploughman guiding them by reins. It is an uſeful plough in ſuch light ſoils as it is generally employed upon.

At *Fig.* 2. is ſeen the *Turn-wreſt or Kentiſh Plough*, a powerful implement in ſtiff ſtrong ſoils, but very heavy. It is uſed in Kent with four horſes abreaſt, and anſwers well among flints or rocks, and in dry ſoils, from its going deep and laying the furrow ſlice quite flat, without any opening in the ſeam. It coſts, complete, 5*l.* 5*s.*

Mr. Boys deſcribes it as conſiſting " of a beam of oak ten feet long, five inches deep, and four broad; behind which is a foot, five inches by three and a half, and three feet and a half long, on the top of which the handles are placed; the foot is tenoned to the end of the beam, and mortiſed at the bottom to the end of the chep. Through the beam, at two feet five inches diſtance from the foot, is a ſheath of oak ſeven inches wide and one and a half thick, which is mortiſed into the chep in an oblique direction, ſo that the point of the ſhare is twenty-two inches diſtant from the beam. The chep to which the ſhare is fixed is five feet long, four inches wide, and five inches deep. The ſhare is of hammered iron, weighs about thirty-two pounds, is twenty inches long, and from four inches and a half to ſeven inches wide at the point.

"The upper end of the beam reſts on a carriage with two wheels, three feet two inches high. On the axle-tree is a gallows, on which is a ſliding bolſter, to let up and down. Through the centre of the axle is a claſp-iron, to which is fixed a ſtrong chain called a tow, that comes over the beam, ſo fixed, as by means of notches (or a pin called a check) to let the whole plough out a greater length from the axle, thereby letting it down to a greater depth."

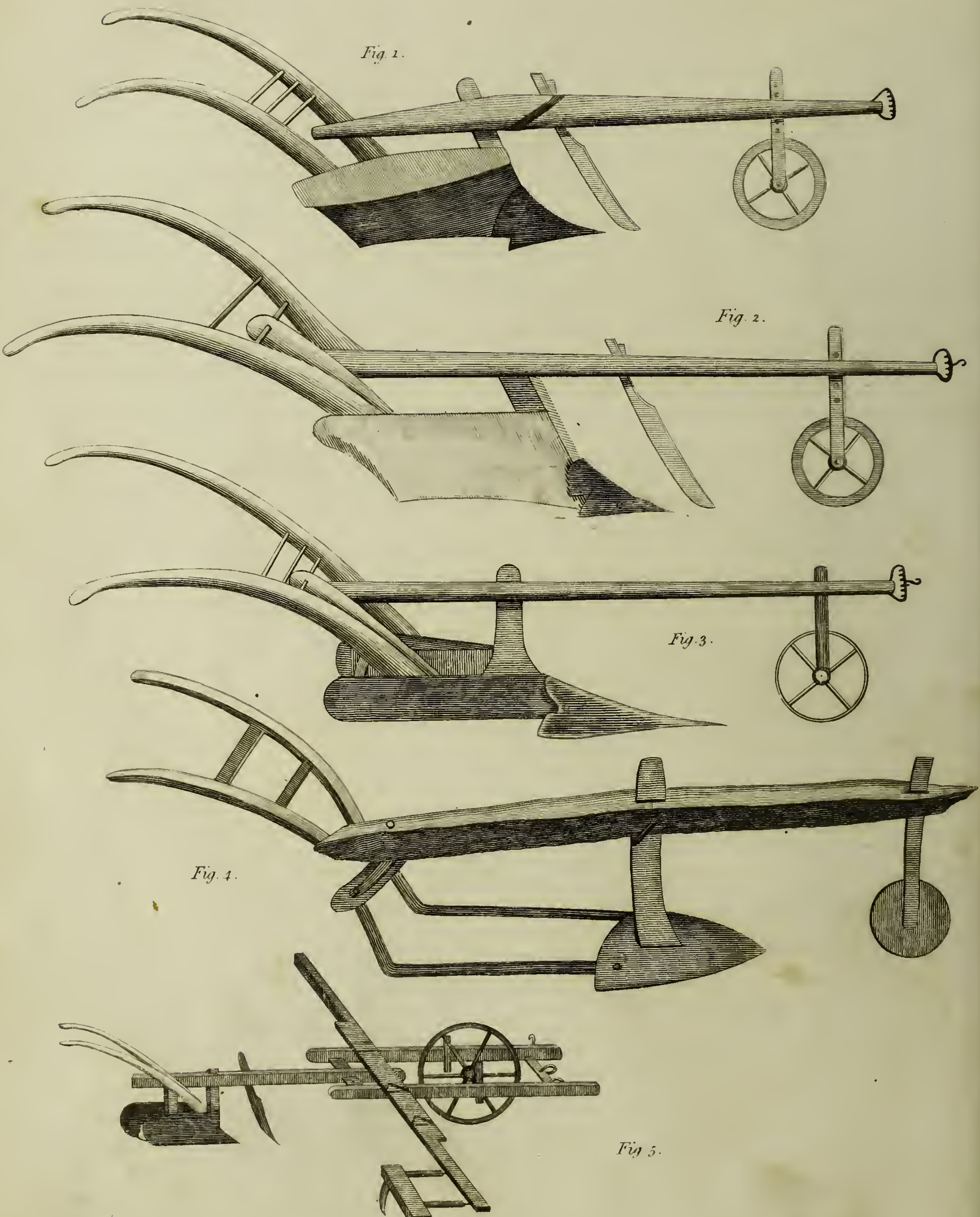


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.

PLATE IV.

Common Wheel-Ploughs.

[*To face Page* 40.]

Fig. 1. Is the reprefentation of a wheel-plough of the Rotheram kind.

Fig. 2. A common wheel-plough ufed in many diftricts.

Fig. 3. Is a double mould-boarded wheel-plough, employed for the purpofe of earthing up crops fown or fet in rows at great diftances.

Fig. 4. Is a fort of fen plough which has been found ufeful in Lincolnfhire. It has a cutting wheel as feen at *a*.

Fig. 5. Is a marking plough, fometimes ufed for regulating the drills, where that fort of hufbandry is to be employed; but more particularly ufeful for marking out ridges.

DOUBLE WHEEL PLOUGHS.

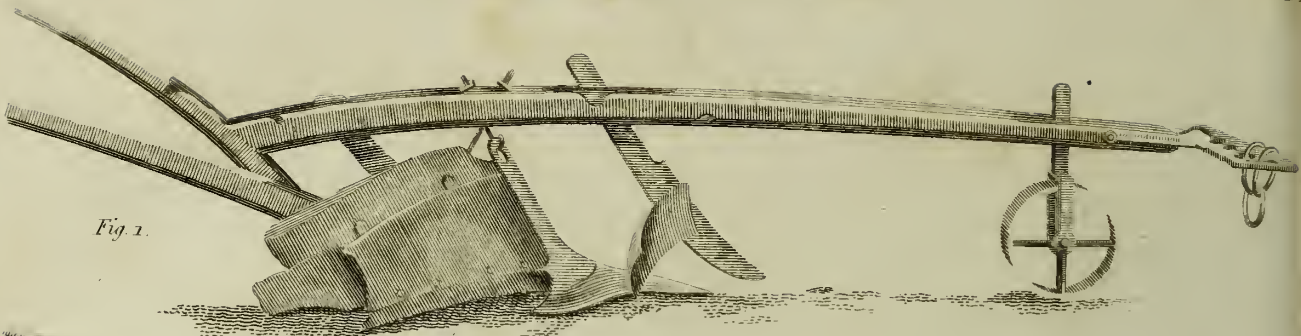


Fig. 1.

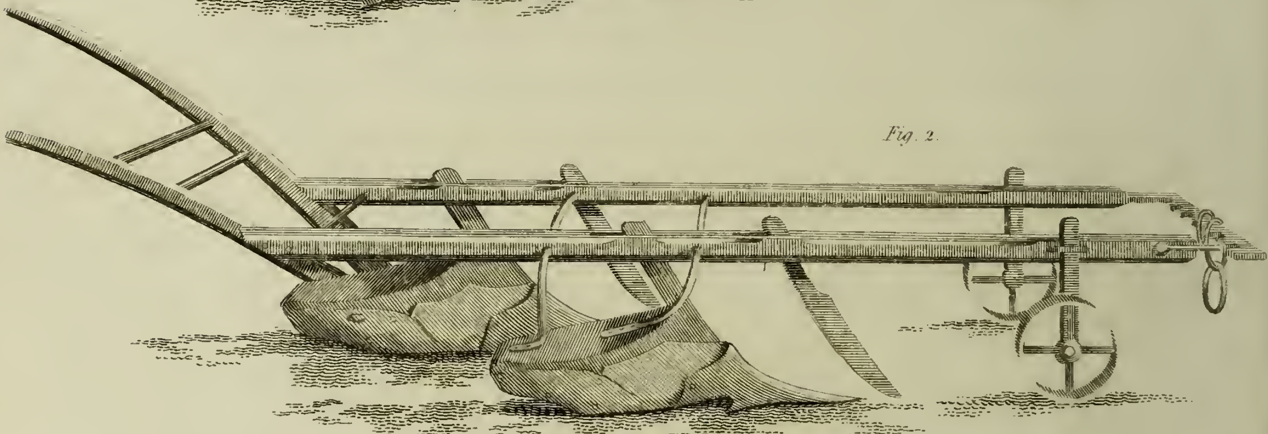


Fig. 2.

3

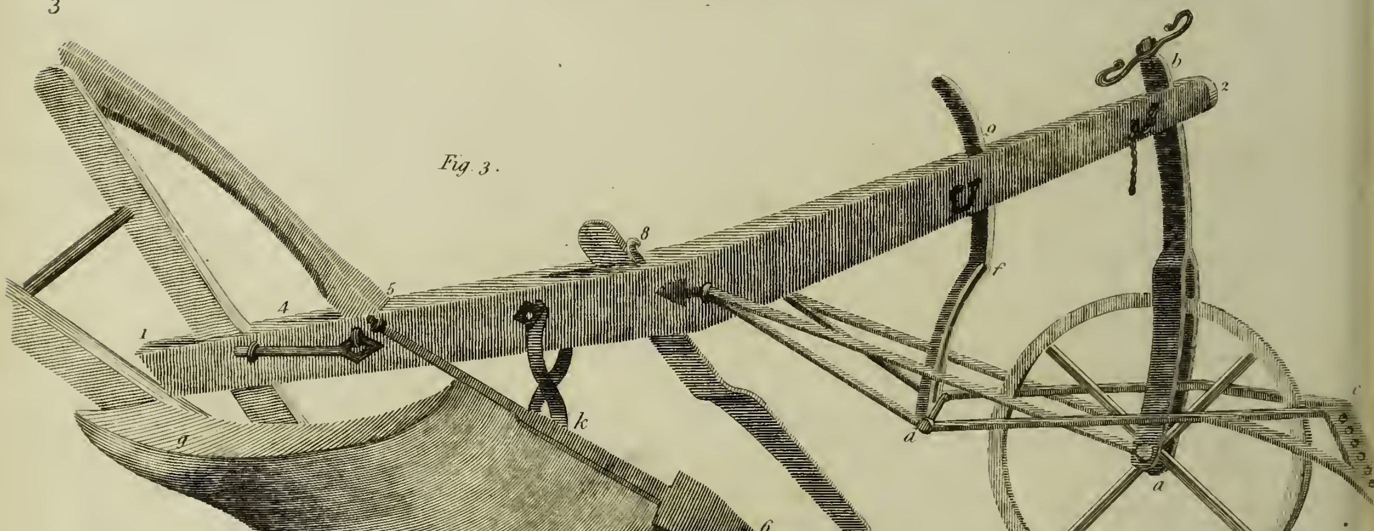


Fig. 3.

Fig. 4.

PLATE V.

Double-wheel Ploughs.

[*To face Page* 40.]

Fig. 1. Exhibits a *Double Plough* ufed in Leicefterfhire. It requires a ftrong team, but ploughs two acres in the day, and goes fteady, without holding, from one end of the furrow to the other. It is made by Mr. Hanford, of Hathem in that county, and cofts about 5*l.* 5*s.*

Fig. 2. Is a *Single-wheeled Skim-coultered Plough.* It is an ufeful implement, and capable of being ufed with the common, without the fkim coulter. It is made as above, and cofts about 3*l.* 13*s.* 6*d.*

At *Fig.* 3. is feen an *Improved Wheel Plough,* invented by Mr. Tugwell;

		Ft.	*In.*
The different dimenfions of which are: from 1 to 3	—	6	0
3 to 4	—	3	8
3 to 5	—	4	3
5 to 6	—	2	5
7 to 6	—	2	8
1 to 3	—	1	5
1 to 8	—	2	10
1 to 9	—	4	8
Heel to tuck hole of fhare	—	2	6½
Tuck hole to point of fhare	—	0	8½
a to b	—	2	4
d to e	—	2	5
c to d	—	1	4
d to e	—	2	5
Diameter of wheel	—	1	9
d to f	—	0	11
g to h	—	0	10½
e to i	—	1	3½
k to l	—	0	9
Breadth at heel	—	0	9
Breadth of fin	—	0	7
Top of beam at the heel to ground	—	0	8½
Mould board projects at top more than breadth at heel	—	0	6

Fig. 4. Reprefents a two-furrow wheel plough, invented and recommended by Lord Somerville, particularly where deep ploughing is not required, and where expenfive teams are kept, as

performing double the work of other kinds. *a a*, the moveable parts of the mould boards attached to the fixed parts by means of flat hinges, thin flexible plates of tempered ſteel or hard hammered iron, ſo as to admit of being ſet to form different inclinations with them. This is effected by means of ſcrews paſſing from the inſide behind theſe moveable parts, but which are not ſeen in the figure. Theſe ſcrews are ſo contrived as to keep the moveable pieces in any poſition, according to the nature of the work, ſo as to lay the furrow-ſlice more or leſs flat. The parts of the mould plates marked with the dotted lines *c c*, as moſt liable to wear, ſhould be twice the thickneſs of the others, to laſt as long as the reſt of the plough.

IMPROVED WHEEL PLOUGHS.

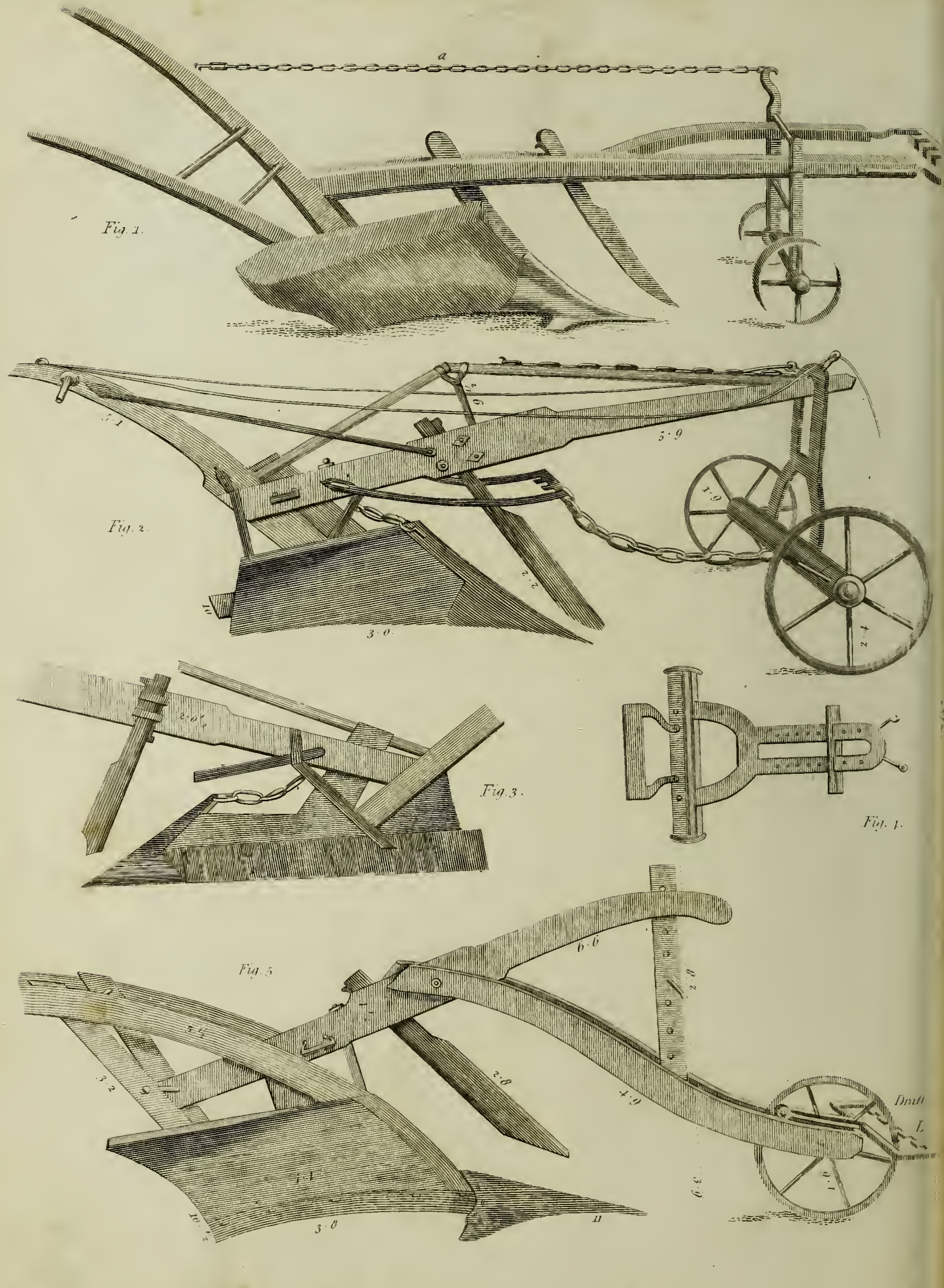


PLATE VI.

Improved Wheel Ploughs.

[*To face Page* 40.]

At *Fig.* 1. is reprefented an improved *two-wheel plough* ufed in the Midland diftricts: *a* the cheek-chain to pull up the wheels in opening ridges or clearing furrows. It is made by Mr. Handford in Leicefterfhire, and cofts, with a double fet of fhares, about 3*l.* 3*s.*

Fig. 2. Exhibits a *wheel-plough* ufed in Suffex for light foils. It is ufually drawn by two horfes abreaft, directed by the holder by reins from the handle, and works fteadily, difpatching much work. Ploughs of this fort are made by Wingham of Nut Bourn, near Chichefter.

At *Fig.* 3. is a back and fide view of the fame plough.

Fig. 4. Explains the manner of fixing the wheel and draught.

Fig. 5. Reprefents another *wheel-plough* employed in hard foils, with three or four horfes fingle or abreaft. It is found ufeful in doing a great extent of work in the day.

Draining Ploughs.

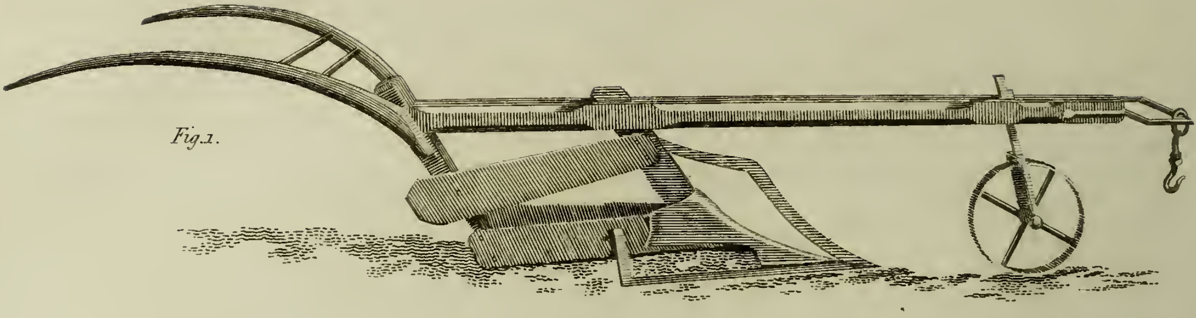


Fig. 1.

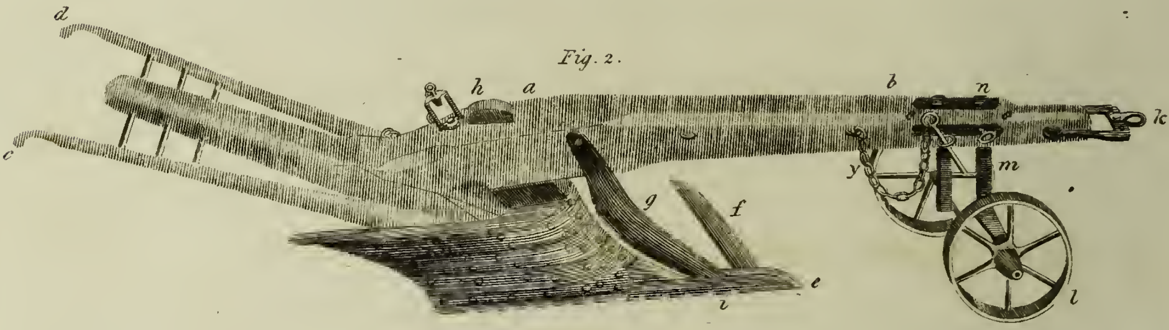


Fig. 2.

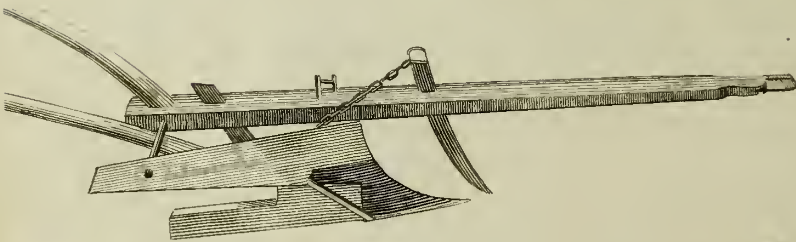


Fig. 3.

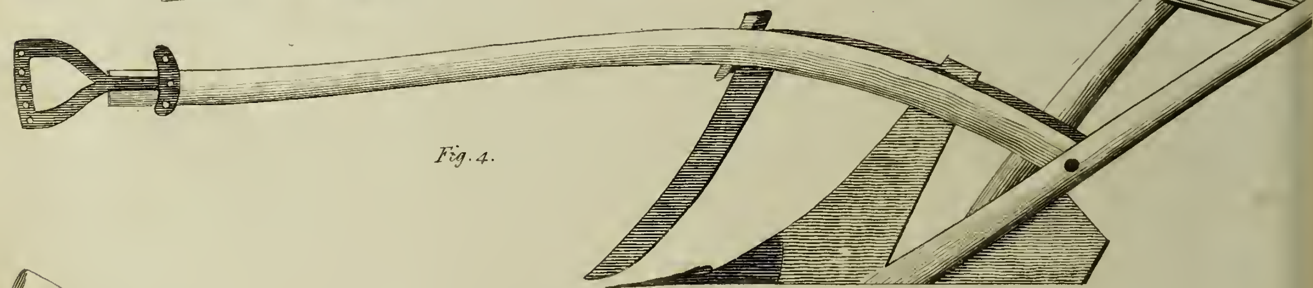


Fig. 4.

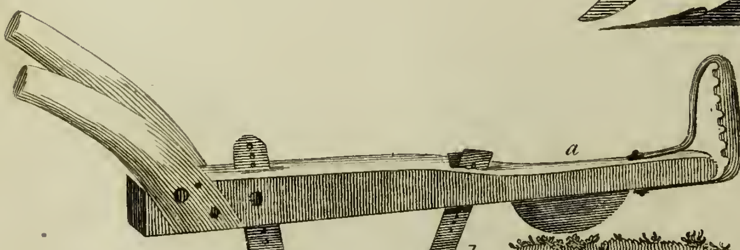


Fig. 5.

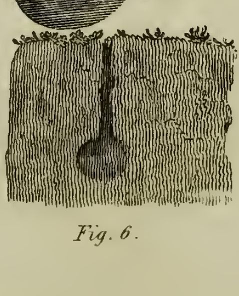


Fig. 6.

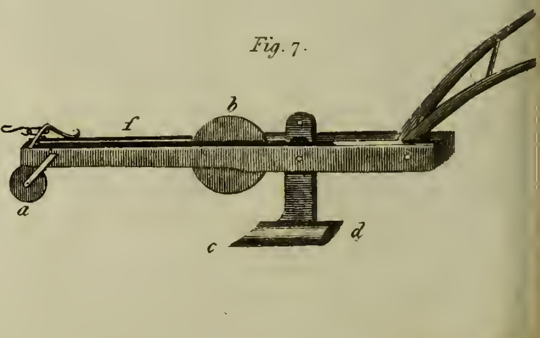


Fig. 7.

PLATE VII.

Draining-Ploughs.

[*To face Page* 40.]

Fig. 1. Reprefents a draining-plough made ufe of in Leicefterfhire.

Fig. 2. Is the reprefentation of a *drain- or gutter-plough* recommended by the Duke of Bridgewater; in which *a b* is the beam; *c d* the handles; *e* the fhare or fock; *f* the coulter or firft cutter of the fod, fixed to the fhare; *g* the other coulter, or fecond cutter, which feparates the fod from the land, and directs it through the fpace or opening between *f* and *g*; this coulter is connected with the fhare and beam; *h i* the fheath; *k* the bridle or muzzle to which the fwingle tree is attached; *l m* two wheels of caft iron, which may be raifed or lowered by fcrews at *n* preffing upon the flat irons *o o*, to which the axis of each wheel is fixed. Thefe wheels regulate the depth which the fhare is to penetrate into the earth; *p* a chain with an iron pin to move the fcrews at *o*.

It has been found ufeful in forming gutter-drains on grafs lands where the foils are of a retentive nature. The power of fix horfes is required in drawing it in foils that have not been drained before. But in opening the old gutters four horfes are fufficient.

Fig. 3 Is a plough employed for opening the furrows in tillage lands.

Fig. 4. Is a draining furrow plough ufed in Northamptonfhire.

Fig. 5. Reprefents the *mole-plough* invented by Mr. Adam Scott, in which *a* is the beam; *b* the coulter; and *c* the cone which forms the drain. It has been lately improved fo as to require much lefs force of draught, by having wheels placed before, and a roller behind, but which are not fhown in the figure. This is an effective implement on lands of the ftiff clayey kind.

Fig. 6. Is a fection of the drain, formed by the mole-plough.

Fig. 7. Is a plough for under-draining, in which *a* is a fmall roller for regulating the depth of the plough; *b* a rolling coulter to cut the turf or other coarfe herbage on the furface. It may be taken out when ufed on arable land; *c* a flat fhare edged in front; *d* bottom of fhare rounded above, oval at the bottom, and pointed to make an opening for the water; *e* pin head for regulating fhare, fo as to form drains at different depths; *f* beam, which is ftrong and plated. It may alfo be wrought by attaching a pair of low wheels with the fhafts, by a chain to the hook *g*.

2

DRILL MACHINES

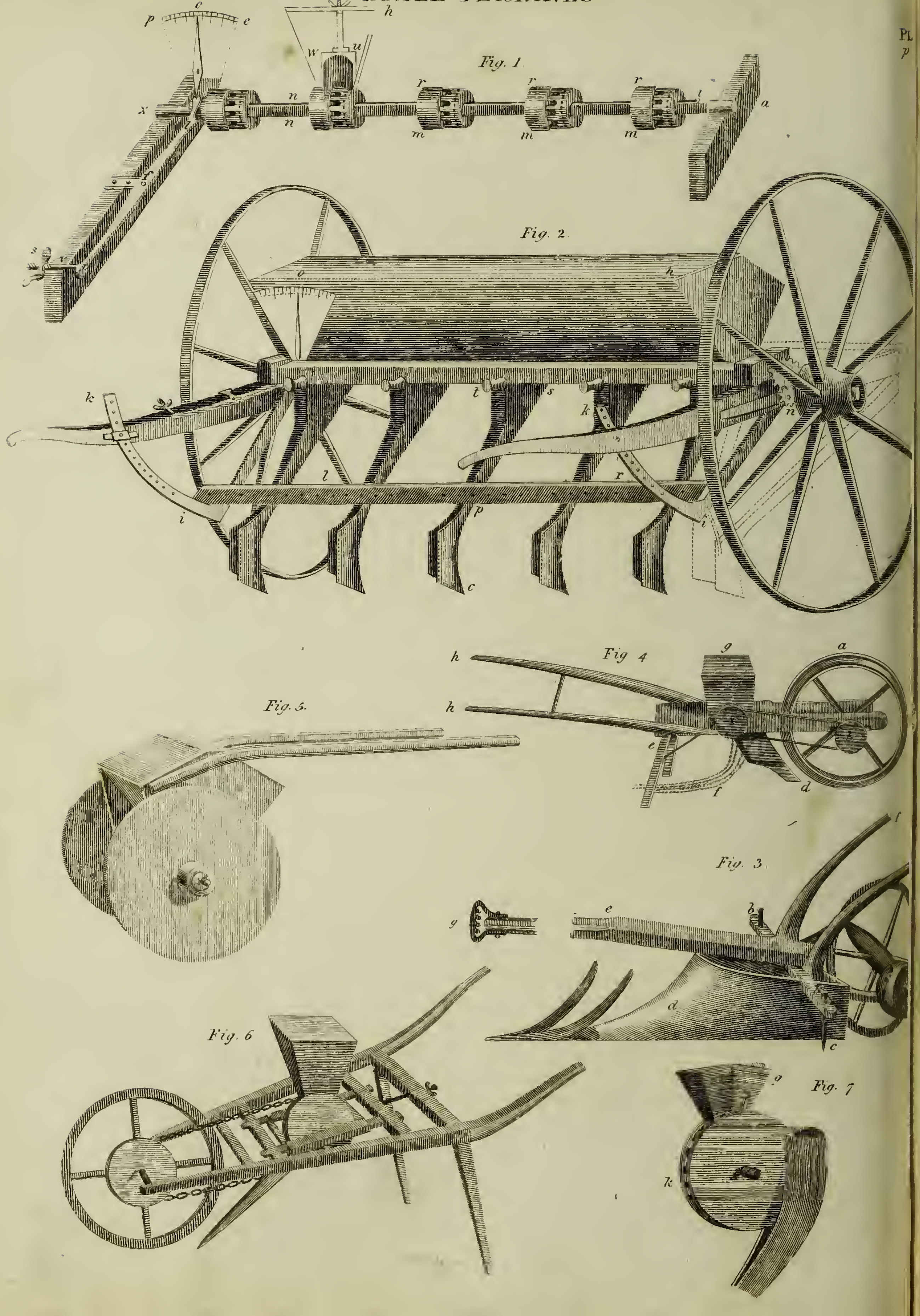


PLATE VIII.

Drill Machines.

[*To face Page* 40.]

Fig. 1. Reprefents the infide part of an ufeful drill machine, by which the quantity of feed is regulated. *a. x* an iron axle, 1 or 1¼ inch fquare, upon which are fixed, at 9 or 10 inches diftance, five, fix, or more, brafs fluted cylinders, the flutes being rather more than a femi-circle ⅝ of an inch diameter, or ⅝ wide and $\frac{6}{8}$ deep. *r. m* are hollow cylindrical rims of hammered iron, which have fegments turned down at right angles, to fit exactly the flutes of the brafs cylinders; the cavities of which are increafed or diminifhed by the fegments of the iron cylindrical rims fliding backwards or forwards in the flutes. This is performed in all the cylinders at the fame time, by a rectangular fpace (*n*) being made in the brafs cylinders, through which paffes a ftraight piece of iron *i. n*, moving on friction wheels at *i*, and faftened to the plates at *l. k*, and alfo to the cylindrical rims *r. m.* *l. v.* is a lever, the fulcrum of which is *f*, and moved by a fcrew S, paffing through the frame at V. The end at *l. k* is forked, and made to fit exactly the fides of the collar or plates of iron *i. k.* By turning the fcrew S, the lever moves the whole of the rims at once, and the cavities are increafed or diminifhed at pleafure: this is done with the greateft facility and readinefs, even while the machine is going and at work; which is frequently neceffary, where the land varies confiderably in quality, upon different parts of the fame ridge: and almoft inftantaneoufly, to fow any kind of grain, and in any proportion; which is fhown upon the fcale *e. o. p*, by the index *k. o* fixed to the end of the lever at *k*.

Fig. 2. Is a view of the machine when ready for work. The coulters and fpouts may be hung differently, as reprefented by the dotted lines, and which is probably the better mode for hilly lands. When employed for fowing turnips, the large hopper is taken off, and a fet of fmall ones fixed upon the half-egg cavities at the end of the brafs cylinders: the quantity is regulated by a tongue fcrewing up and down.

This machine was invented by Mr. Bury, and defcribed in the Northumberland Report.

Fig. 3. A drill plough very ufeful in fowing turnips, invented by Mr. Mure. *a* the fpindle on which the feed-box is fixed; *b b* the crofs piece in which the drill coulter *c* is faftened; *d* the mould board; *e* the beam; *f f* the handles; *g* the copfe by which it is drawn.

Fig. 4. Is the reprefentation of a turnip-drill, invented by Mr. Knight. *a* the iron wheel running on the edge formed by two concave fides, makes the groove for the feed; *b* a wheel moving on the fame axis with the former, and turning the wheel *c* by a ftrap, gives out the feed. By having different fizes of wheels, *d. b*, more or lefs feed is fown as they increafe or diminifh the rapidity of *c*. *d* the tube through which the feed paffes into the channel formed by the iron wheel; *e* feet of the implement; *f* fix lengths of jack chain for covering the feed; *g* the feed-box; *h h* the handles. There are two holes before the axis of the great wheel for receiving two pieces of cane, which mark the proper width of the intervals between the rows. The angle on the edge of the wheel, and the weight of the implement, are more or lefs acute and heavy according to the ftrength of the foil.

Fig. 5. An implement for drilling turnips, in which the wheels are ſolid. It has been uſed with ſucceſs on ſome of the Duke of Bedford's farms.

Fig. 6. Another drill of the barrow kind, which has been found to anſwer well in ſowing turnips.

Fig. 7. Section of ſeed-box *g* on a large ſcale; the wheel *c* the ſame: it is fixed on axis *i*, which is pierced with holes at K. A ſmall bruſh marked *l* rubs againſt the cylinder to clear out ſeeds that may be detained in the holes.

HORSE HOES.

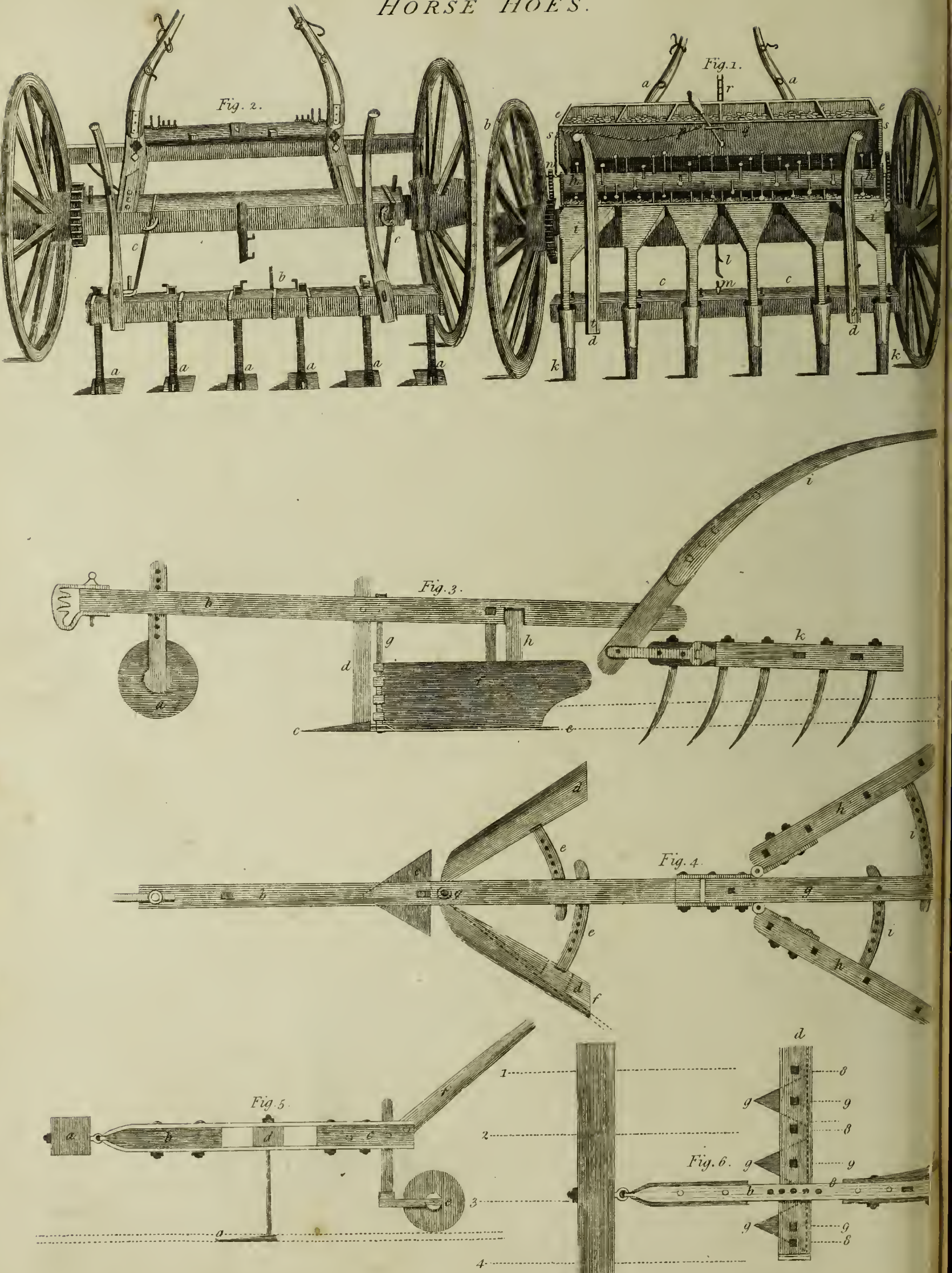


PLATE VIII.

Drill Machine.

[*To face Page* 40.]

Fig. 1. and 2. Reprefent Cook's improved Drill and Horfe-Hoe.

Fig. 1. Is the drill implement; *a a* the fhafts applied to the axis of the wheels; *b b* the wheels; *c c* the coulter-beam, having holes at proper diftances for the coulters; *d d* the handles fixed to the coulter-beam, as well as the axis of the wheels, by ftaples or hooks and eyes; *e e* upper feed-box in partitions covered by a lid: *f f* lower feed-box in partitions; *g g* flides between upper and lower feed-boxes, for regulating quantity of feed; *h h* cylinder with cups of different fizes for grain or feeds of different fizes, which take up and drop the feed into the funnels *i i*, to be conveyed to the drills in the land *k k*; *l* a hook applied to the axes of the wheels, to receive the links of a chain from the coulter-beam, in order to prevent the tubes from being difplaced in croffing gutters, &c. *m* a pin of iron projecting from the coulter-beam, which by being lifted on hook *l* bears the coulters out of the ground in turning, &c. *n* a cog-wheel; *o* another cog-wheel turned by wheel *n*; *p* a lever and ftring paffing over a pulley to the axis of the cylinder *h*, by moving which to the notch in ftaple *q*, the wheel *o* is lifted out of generation with wheel *n*, by which means the diftribution of feed is prevented at pleafure; *r* an iron bar perforated with holes, by which, with the pin put through the holes, the feed-box may be elevated or depreffed fo as to keep the lid level in all fituations; *s s* two ftaples in the ends of feed-box for receiving flips of wood with canvass, to prevent the wind interrupting the feed, as well as dirt from falling from the wheels into the funnels *i i*.

Fig. 2. Is the fame implement fet for horfe hoeing. The fhafts, axis, wheels, coulter beam, and handles, the fame as in fig. 1.; the feed-box *ee*, the cylinder, *hh*, the funnels *ii*, and the coulters *k k* being removed; and the hoes *aaaaaa* introduced in the place of the coulters, *bc* a guide rifing from the hoe beam for directing the hoes; *c c* the fhanks by which the machine is drawn.

Fig. 3. Is a profile of Mr. Amos's expanding horfe-hoe and harrow; *a* the regulating wheel 10 inches in diameter, capable of being adjufted fo as that the fhares may cut at various depths; *b* the beam, fix feet and a half long and three and a half fquare; *c* leading fhare, riveted on fhaft *d*, is an equilateral triangle of twelve inches; *d* fhank of fhare fixed in beam, two inches by half an inch fquare; *e* edge of expanding fhares, two feet long and five broad; *f* left hand mould-board, two feet long and ten by fix inches fquare, made of light wood, hooked on iron rod *g*, and fixed to fhank *h* by fcrew bolt; *g* iron rod paffing the hind part of leading fhare, the fore part of expanding fhares, the mould-board hooks, and the beam in which it is fixed by nut and fcrew; *h* iron fhank fixed to the expanding fhares, kneed at top, where a circular part paffes the beam, and regulates the width of the expanding fhare; *i* the handle three feet from the ground line, and the part held by, three feet behind end of beam; *k* profile of fmall triangular harrow with expanding fides fixt to end of beam.

Fig. 4. A horizontal view of the expanding hoe and harrow; *b* the beam containing mortices for the fhanks of the regulating wheel and leading fhare; *c* leading fhare, to which expanding ones are fixed by bolt *g*; *d d* expanding fhares fixed to leading one *c*; *e e* circular

radiuses of ſhanks fixed to inſide of expanding ſhares, which go through beam and regulate width of hoe, fixed to different widths by bolts paſſing through them and beam; dotted lines *f* upper parts of mould-boards; *g* middle bun of expanding harrow three inches ſquare and two feet nine inches long; *h h* expanding buns, three inches ſquare and two feet ſix inches long, fixed to middle one by ſtrong hinges; *i i* two circular iron radiuses fixed in expanding buns, and ſerving to regulate the harrow to any width.

Fig. 5. The profile of a ſix-ſhared horſe-hoe on the principle of the pentagraph, improved by Mr. Amos by the addition of two caſtor-wheels to regulate depth. It moves with eaſe to right or left; *a* a ſection of coulter-bar of drill, to which it is fixed by eye-bolt; *b* piece of aſh three inches ſquare and ſixteen long, narrow before to hook on bolt paſſing coulter-bar; *c* another piece thirteen inches long, fixed between iron bar at twelve inches diſtance by four ſcrew-bolts; the bars are two inches broad, half an inch thick, and forty-one long; *d* ſection of coulter-bar four by three inches ſquare, moveable between pieces of wood and iron bars; *g* ſhare with ſhank ſixteen inches long and one and a half by half inch ſquare, fixed in coulter-bar, being riveted in hind part of ſhare; *e* caſtor-wheel, eight inches in diameter and two thick at centre; *f* handle fixed to piece of wood *c* by two bolts and ſcrews.

Fig. 6. A horizontal view of a ſix-ſhared horſe-hoe; *a* coulter-bar of drill, to which it is fixed in working; *b c* iron bars, between which coulter-bar moves on bolt, in which are holes for ſhifting in different ways; *d* bar in which hoes are fixed; *figs.* 8. and 9. manner of fixing them when rows of corn are eight or nine inches aſunder; *g g g* three ſhares in form of triangle, two fore ſides of which are ſeven inches long, and hind ſide ſix; *f* handle for left ſide fixed to end of ſide frame by two bolts: the numbers 1, 2, 3, 4, repreſent four rows of corn at nine inches apart.

Fig. 7. A horizontal view of coulter thirteen inches long below coulter-bar. There are ſeven, which are uſed in place of hoes in ſtiff ſtony or weedy land.

Fig. 8. A profile of a coulter made ſharp on fore edge in order to operate more eaſily.

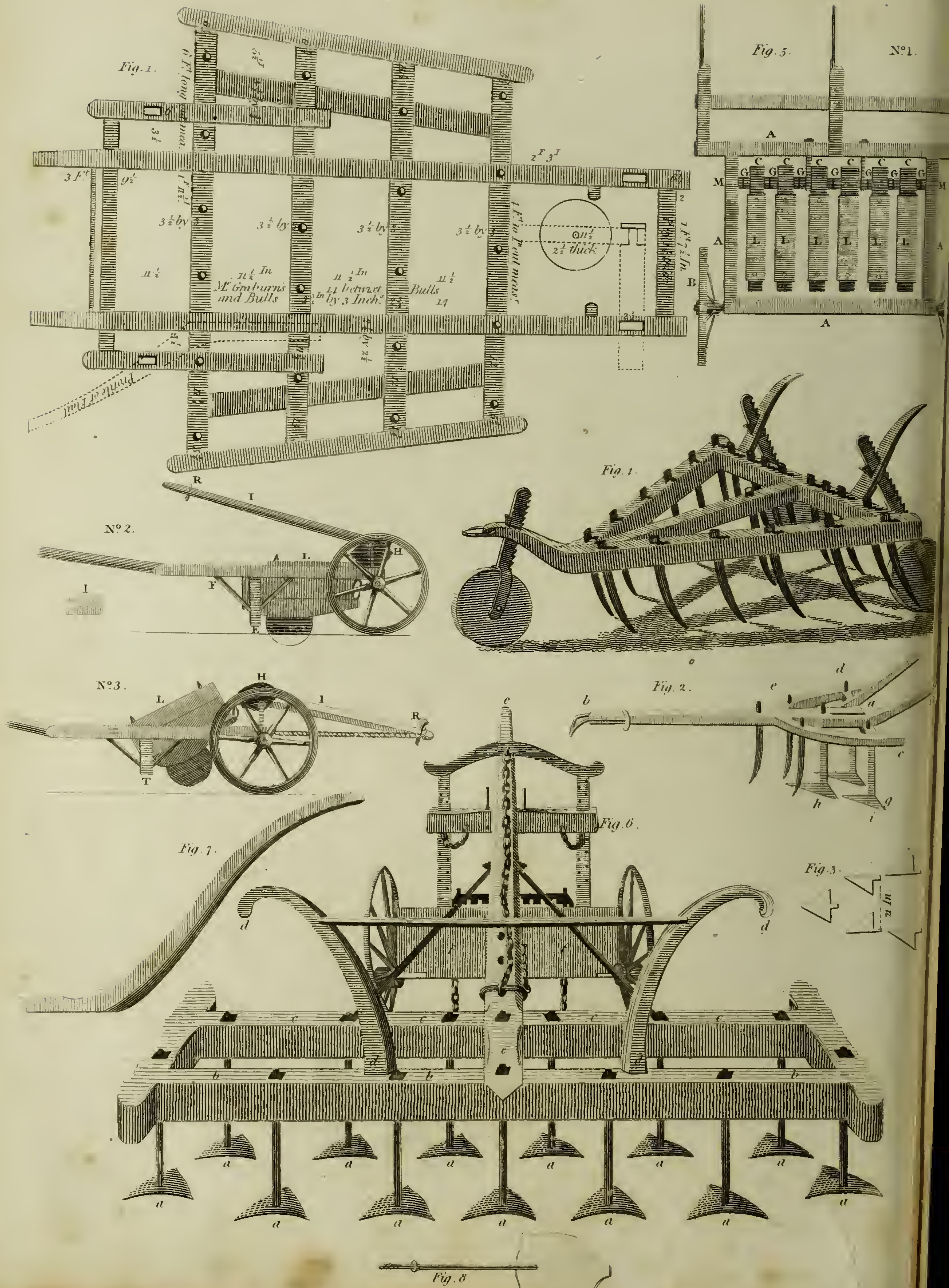


Fig. 1.
6 F.t long and mea.
3 F.t
9½
3½ by 3
11½
11½ In
M.r Graburn's and Bulls
11½ In
14 betwixt by 3 Inch.s
Bulls
14
2 F 3 I
2½ thick
Profile of Fluil
Fig. 5.
N.o 1.
A
C
G
M
L
B
N.o 2.
R
I
L
H
F
E
Fig. 4.
N.o 3.
H
L
I
R
T
Fig. 2.
b
e
d
a
c
h
i
g
Fig. 6.
Fig. 7.
Fig. 3.
d
c
b
e
a
Fig. 8.

PLATE X.

Cultivators.

[*To face Page* 40.]

At *Fig.* 1. is the repreſentation of a *Scuffler* employed with great advantage by Mr. Grayburn in Lincolnſhire, in putting in grain crops on turnip-fed lands after one ploughing. The ſeed is by this implement ſcuffled in, and the neceſſity of a ſecond earth avoided.

Fig. 2. An implement of the ſame kind, that is made uſe of in Northumberland for hoeing bean-crops drilled at thirty inches. It is alſo capable of hocing and ſtirring ſtrong lands in dry ſeaſons, when the plough cannot be employed. With other proper hoes put into it, the purpoſe of ſcufflers and cultivators, &c. is anſwered in a very cheap and eaſy manner. *a b* the beam five feet in length, and in height at *b* 16 inches; *c e* and *de* curved lines having a radius of 24 inches from *c* and *d* as centres: *a* to *f* the length of ſtilts 42 inches; the length of the ſhanks of hoes from *g* to under ſide of beam 15 inches; length *g* to *h* 7½ inches; breadth from *g* to *i* 5½ inches: *c e*, *d e* holes in the ſides, and *c d* in the end, for the reception of ſmaller hoes for light ſoils, as to hoe from 18 to 30 inches at once. When made a little wider to take in four hoes, it anſwers well for hoeing wheat drilled at 10 or 12 inches. It is drawn by a ſingle horſe, and coſts only from 30 to 40s.

Fig. 3. Shows the ſizes of the hoes.

Fig. 4. An *Improved Cultivator* with wheels and handles. It is found uſeful in preparing and reducing ſtiff heavy ſoils. From its weight, and the great length of the tines or coulters, it is a very powerful implement.

Fig. 5. Is the repreſentation of a *Sward-cutter*, or implement for cutting tough ſwards in a croſs direction previous to their being broken up by the plough, or before the operation of paring and burning is begun. It is likewiſe uſeful for breaking down and reducing the cloddineſs of tillage lands, when in preparation for different ſorts of crops that require a high degree of pulverization.

Different parts of the machine are repreſented at No. 1, 2. 3.—No. 1. AA, &c, is a ſquare frame 3 feet 4 inches from the fore to the hind part, by 4 feet 3 inches, the breadth of the machine within ſide; the timber (when of fir) 4 inches ſquare, placed on two wheels BB, 3 feet diameter. CC, &c. are ſix ſtrong pieces of wood, called *bulls*, 3 feet long, 5½ inches broad, the thickneſs 6 inches at E, and tapering to 3 inches at F. Into theſe are fixed the cutting wheels, which are iron, 13 inches diameter, ¾ths of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of ſuch thickneſs as will allow the edges to be well ſteeled. The wheels are fixed by two bolts going through the bulls. GG, &c. are hollow pieces of wood, called *thorls*, each 3½ inches long, which incloſe the bolt MM, and keep the bulls CC, &c. at their proper diſtances, but may be made longer or ſhorter at pleaſure, according as the ſward requires to be cut in larger or ſmaller pieces. The iron bolt MM goes through two pieces of wood or iron, PP, 7 inches long, clear of the wood, ſupported by iron ſtays fixed to the frame, and through all the bulls. HH, No. 2. and 3. a cylinder or ſegment of wood, 7 inches diameter, called a *rocking tree*, which goes acroſs

2

the frame, and moves on the pivots fixed into it, one at each end, ſupported by an iron bolt or piece of wood mortiſed into the frame, 8 inches high, as appears at No. 2. and 3. to which 6 chains or ropes are fixed by hooks, at different diſtances, as you want your cuts, 9, 8, 7, or 6 inches from one another, and are joined to the end of each bull in which the cutting wheels run; ſo that when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls with their cutting wheels are raiſed out of the ground at once, as at No. 3. by which means the machine may be turned without any danger of ſtraining the wheels. LLL, &c. No. 1. 2. 3. are weights of freeſtone, 26 inches long and 6 inches broad; the under one 4 inches thick, the upper one 3 inches thick; weighing about 64 lbs. the under, and 48 the upper; each of them having two holes, through which iron ſpikes, firmly fixed in the bulls, paſs, in order to keep them ſteady. When the ground is eaſily cut, the under ſtone may anſwer; when more difficult, the other ſtone may be added; ſo that every wheel may have 7 ſtone weight upon it, which has been found ſufficient for the ſtiffeſt land and tougheſt ſward the machine has ever been tried on. Weights will anſwer fully better, but are more expenſive. The lever I, No. 2. 3. which ought to be 5 feet long, muſt have a ſliding rope on it, fixed to the back part of the frame; ſo that when the cutting wheels are all taken out of the ground three or four inches, by the rocking-tree's being turned partly round by the lever, the rope may be fixed to it by a loop over the pin R, No. 3. Thus all the cutting wheels are kept out of the ground till the machine is turned; and then, by moving the loop off the pin, it ſlips back towards the frame, and the lever is gently let back to its place, as in No. 2. by which the cutting wheels are put into their former poſture, by the weights fixed on the bulls in which they run. PP, No. 1. a ſmall bolt of iron, with a hook on one end of it, to ſtrengthen the bolt MM, to be hooked on the centre of it, and joined to the frame by a nut and ſcrew. For a ſingle-horſe ſward-cutter (which has only four cutting wheels), a pair of ſhafts are uſed, and may make the two ſides of the frame without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix. One man manages the machine and drives the horſes. He begins his operation by firſt meaſuring off 20 or 30 paces from the machine on each ſide, and there fixing poles. He then cuts the field acroſs, as near at right angles with the ridges as he can.

Fig. 6. An *Extirpator* uſed in Suffolk for the purpoſe of clearing land; which is ſaid to be a very effective implement. In the figure is ſeen a back view of the machine, when put together ready for work: *a* the ſhares, eight inches broad and nine inches long, which are fixed to ſtalks, riſing ten inches. The diſtance between them is eleven inches: *b* the hind ledge, ſix feet long, and about four inches ſquare: *c* the fore ledge, five feet and a half long, four inches ſquare; the diſtance of theſe ledges is twelve inches: *d* the beam, ſeven feet long; its elevation is three feet three inches. See fig. 7. *e* the handles.

Fig. 7. A ſide view of the beam.

Fig. 8. Repreſents a ſhare with its ſtalk.

This implement is capable of being fixed to the wheels, &c. of a common wheel-plough, and made to go ſhallower or deeper in the ſame manner.

COMMON HARROWS.

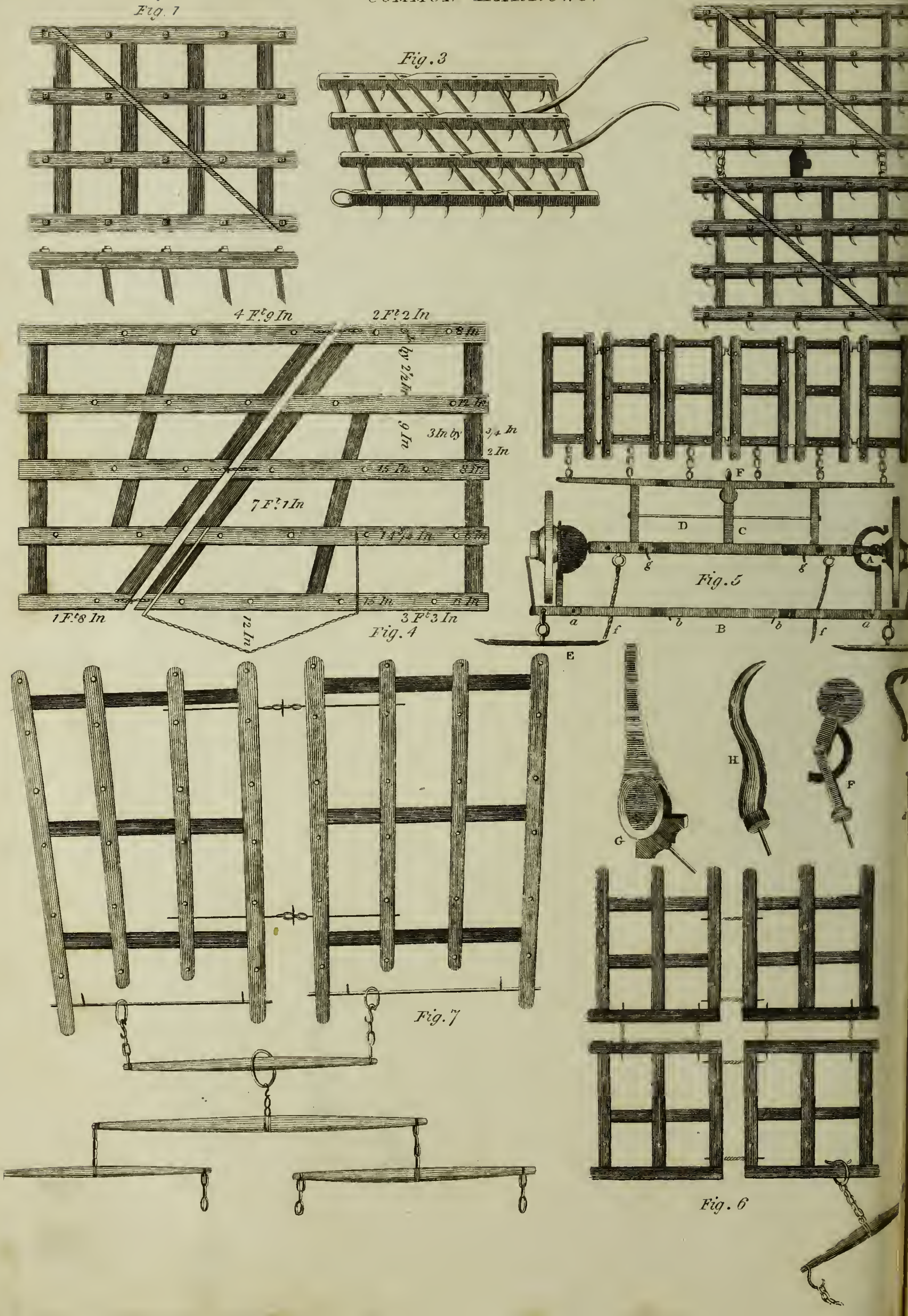


PLATE XI.

Common Harrows.

[*To face Page* 40.]

Improved Common Harrows are much employed in many diſtricts.

Fig. 1. Is a *Common Harrow*, frequently made uſe of in firſt reducing the uneven ſurface left by the plough.

Fig. 2. A *Double Harrow* of the ſame kind.

Fig. 3. A *Jointed Brake Harrow*; to which are handles fixed behind for the purpoſe of raiſing it occaſionally, when it may be neceſſary to clear it from roots, &c.

Fig. 4. Is an *Improved Harrow* made uſe of by Mr. Grayburn in Lincolnſhire. From its being connected by hinges in the middle, it may be employed with great advantage where the ridges are much raiſed. It is recommended in the Agricultural Survey of that diſtrict.

Fig. 5. A *Wheel-Harrow* invented by Mr. Knight, by which the ſtreſs on the horſes is rendered leſs, and the harrow not ſo liable to choke up. It is conſtructed with two joints, A A, in the axle tree, one of which is covered, as when the harrows are at work; the other uncovered, to ſhow the conſtruction of the joint; and two joints, *a a*, in the front of the bar, by means of which the pliability of the tree, and that of the bar, humour the wheels, and keeps them in their proper directions in the furrow; and, requiring very little ſcope of ground, the turnings are rendered convenient and eaſy. If in working the land the breadth of the furrows is varied, it is contrived, in order to make the harrow narrower, that that part of the bar B, which is faſtened by two pins *b b*, may be taken off when requiſite; part of the axle-tree, and part of the hind-bar C, both which are faſtened by the iron bolt D, are alſo to be removed; and the remaining outward parts to be joined and faſtened by one of the two pins in the bar, and by a ſhorter bolt *d*, ſhown ſeparate, and intended for the axle-tree and hind-bar. And when two horſes which are unequal in height are wrought, as the horizontal direction, or evenneſs of the joints, may be deſtroyed in ſome degree; to remedy and ſupply the deficiency in the horſes, the whipple-tree E is made to be heightened or lowered by means of notches *e*, ſhown ſeparate, to which it is connected by a ring. In light barley-lands, to accommodate the harrow for one horſe, by narrowing it as directed above, there are two ſtrings conveyed by two rings from the axle-tree, through two loops, *f f*, under the front bar. The wheel F, under the hind-bar, which is ſhown enlarged and ſeparate in the plate, will ſupport the bar; and by this aſſiſtance the harrow is conveyed to the field on the axle-tree bar, as a ſubſtitute for a ſledge: there are alſo two wooden pegs, *g g*, by which the harrows, when turned upon the carriage, are ſecured. To leſſen the expenſe of iron in this harrow, an axle-tree and joints may be readily conſtructed in wood, upon the ſame principle as ſhown in the plate ſeparate at G; though preference ſhould be given to iron. If the wheel under the hind-bars be not adopted, there is a ſlider H, ſhown ſeparate, which works with a pin, and, when not wanted, is turned and faſtened under the axle-tree. As it is often found uſeful to heighten or lower the harrow occaſionally, particularly on broad lands riſing in the middle; where of courſe the middle harrow takes moſt hold, and generally requires the leaſt; this may be eaſily effected, by fixing irons, with notches, like thoſe on the fore-bar, by which the whipple-trees are ſupported, on the hind-bar, inſtead of the hooks, and putting the hooks on thoſe irons.

At *Fig.* 6. A *Four-ſquare Harrow*, employed on new-incloſed and broken-up lands in the midland diſtricts, where the ground is very uneven.

Fig. 7. An *Improved Harrow*, with *running bulls*: By this contrivance the harrows are prevented from riding on each other, or turning over at the ends of the ridges in returning. They are made by Mr. Hanford, and found to anſwer well in Leiceſterſhire. The price about 3l. 3s.

IMPROVED IRON HARROWS.

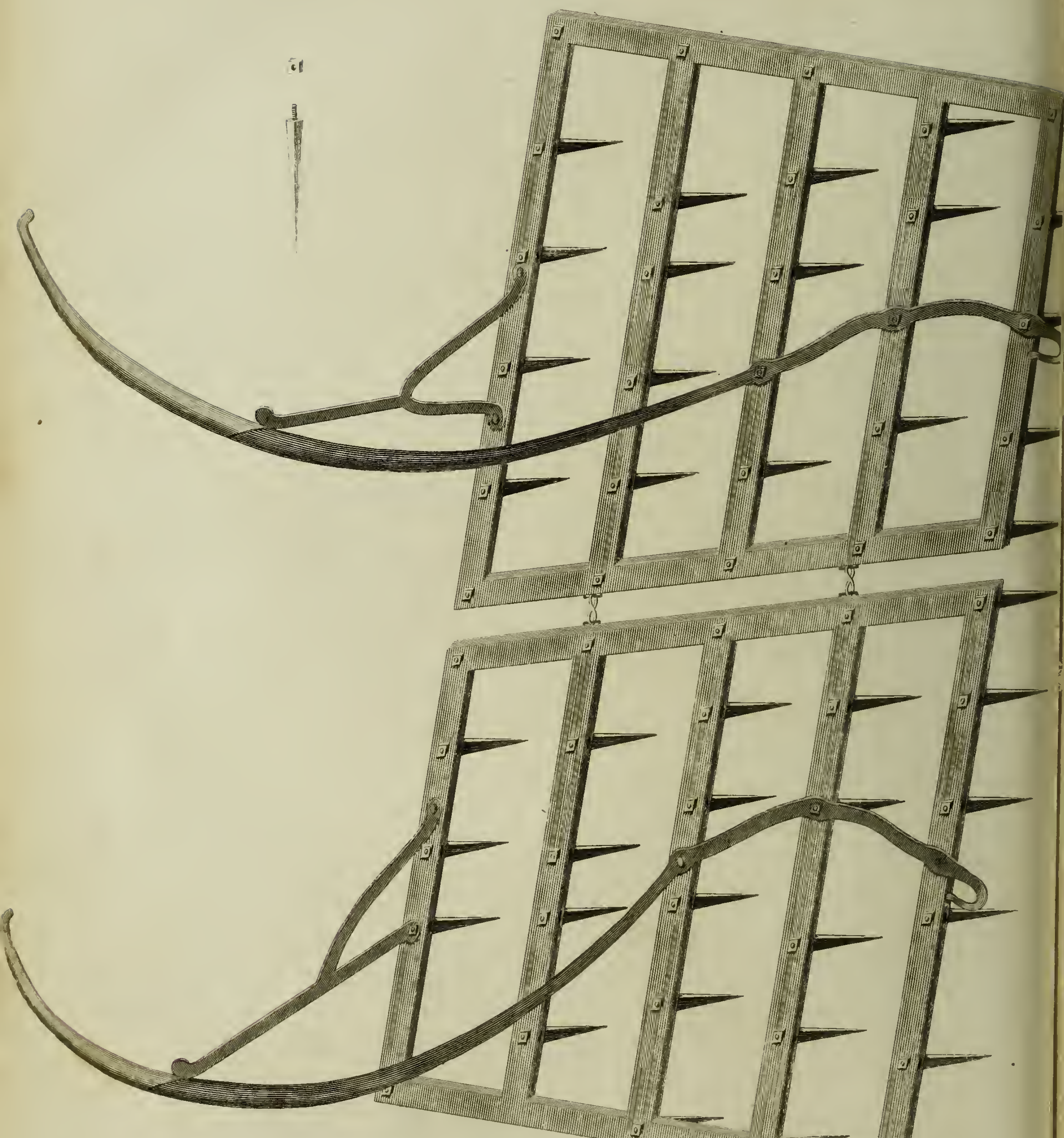


PLATE XII.

Improved Iron Harrow.

[*To face Page* 40.]

THIS gives the reprefentation of an iron harrow, which Mr. Young has had conftructed of that metal from finding that thofe formed of wood are liable often to fall to pieces, and befides to be too light for fome forts of work. Every tooth fcrews through a double frame feparated by iron wafhers for greater fteadinefs; and there are handles fixed for the eafe and convenience of lifting or preffure. Thefe harrows are found to anfwer perfectly well. The price is 6l. 6s. It is obferved that all harrows fhould have handles, that the clods, or tufts of weeds, may not be dragged along, to fave the trouble of raifing them in order to clear them. Any fmith may conftruct a pair from this reprefentation, varying the fhape according to circumftances.

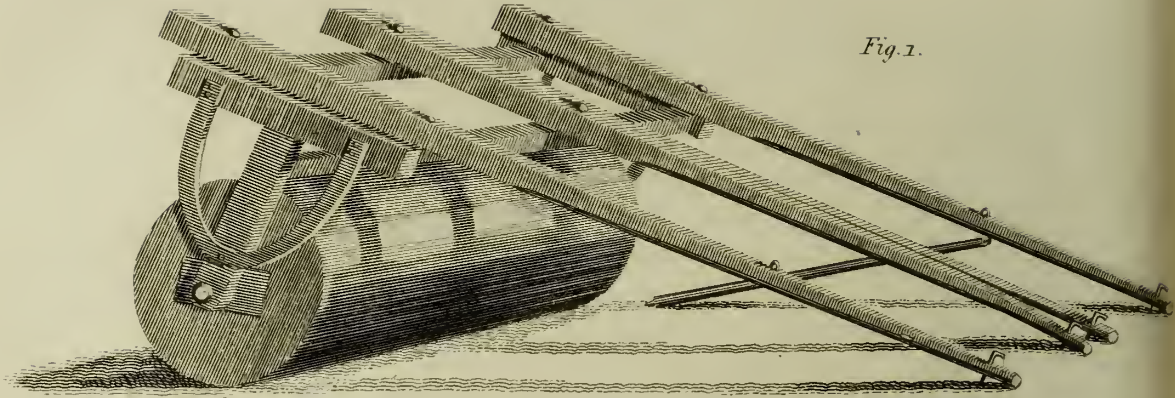
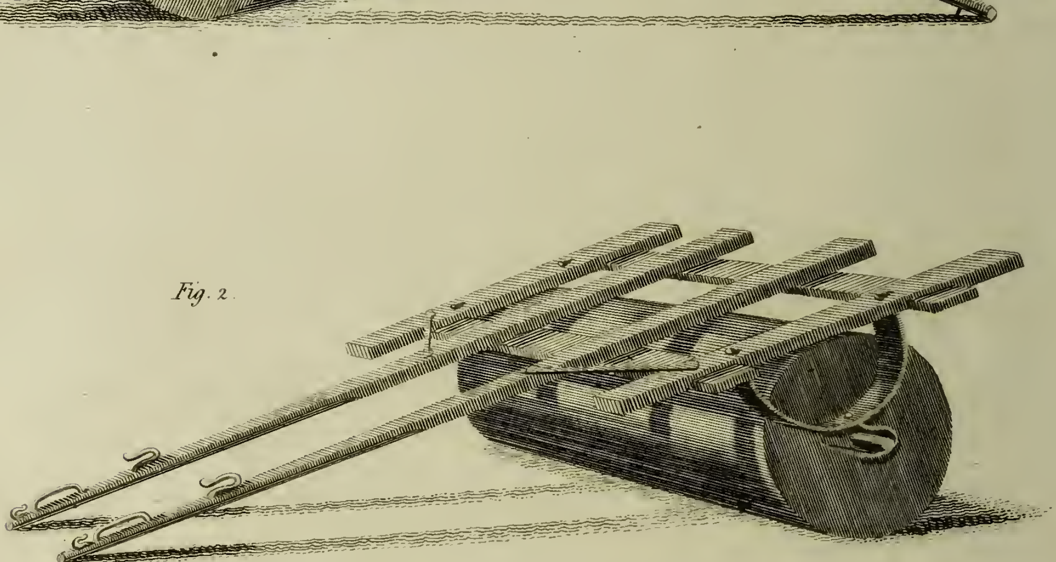


Fig. 1.

Fig. 2.



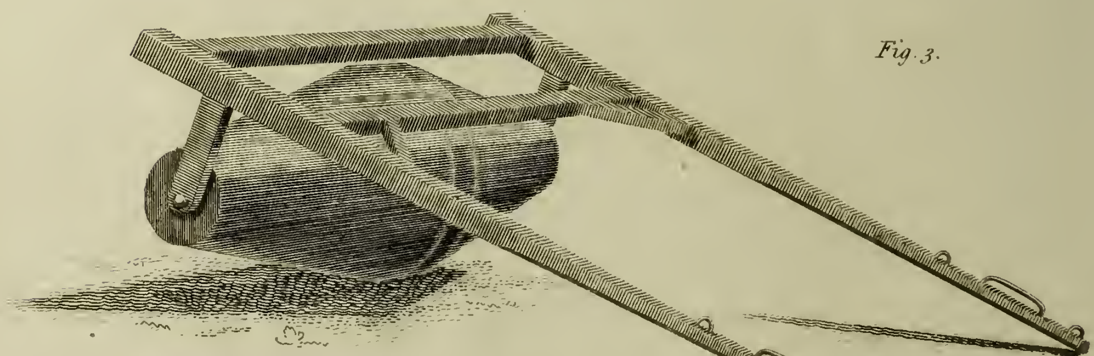


Fig. 3.

PLATE XIII.

Rollers.

[*To face Page* 40.]

Fig. 1. Is the repreſentation of a *common graſs-roller*, employed for rolling hay lands in the county of Middleſex.

It is drawn by three or four horſes abreaſt.

Fig. 2. Is a common *ſtone roller*, made uſe of in many of the northern diſtricts for rolling arable lands.

Fig. 3. Exhibits the plan of a *furrow roller* invented by Mr. Pinchard, for rolling the furrows in hilly and other lands, where the common rollers cannot be employed.

2

THRESHING MACHINES.

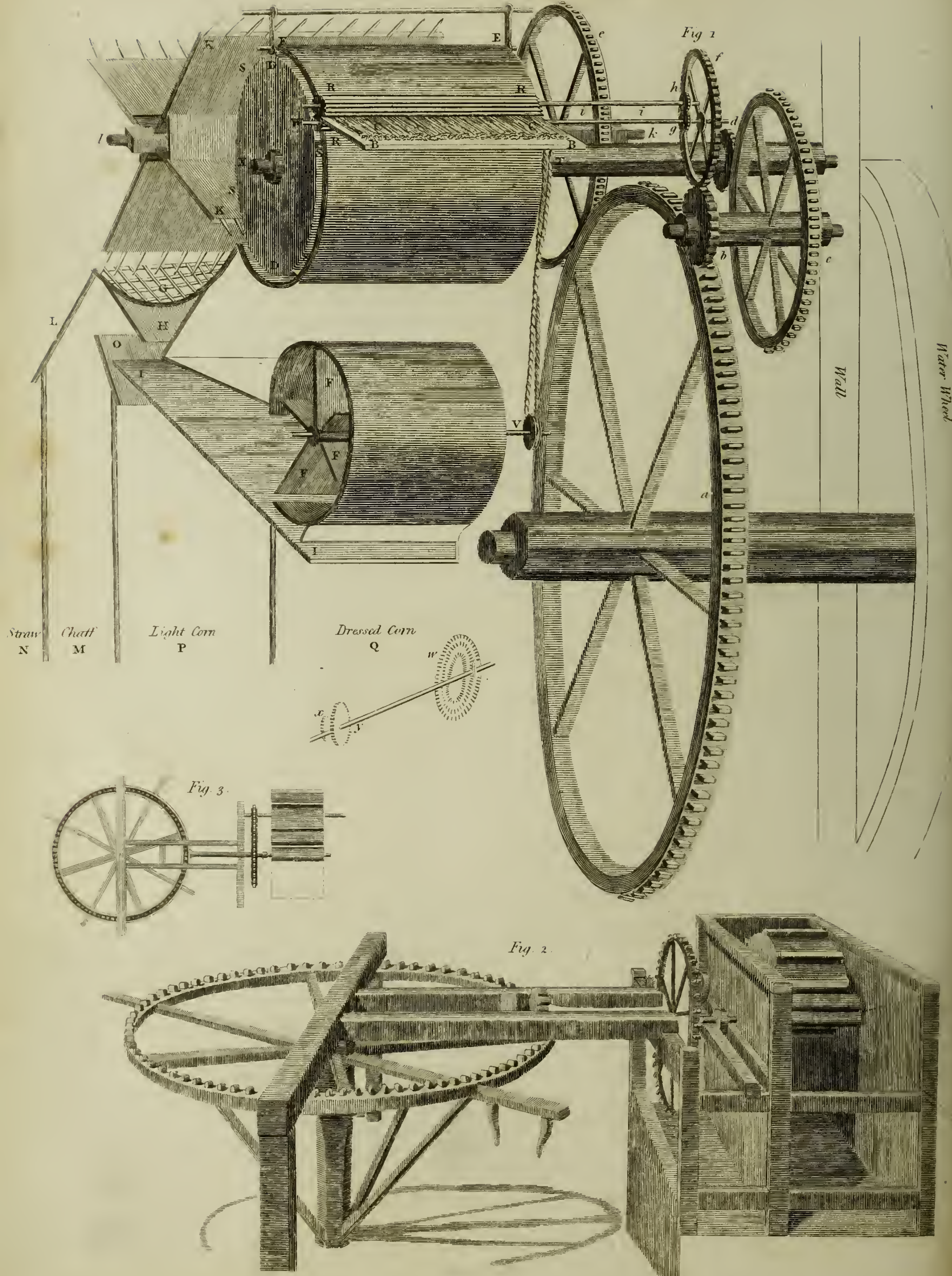


PLATE XIV.

Thrashing Machines.

[*To face Page* 40.]

Fig. 1. is the reprefentation of a powerful thrafhing machine, in which B B is a horizontal board or table five feet long by three feet four inches broad, on which the corn CC is *evenly fpread*, and prefented to the caft-metal fluted rollers RR (four inches in diameter), which take it regularly in, and by their weight and fharp edges hold faft the ftraw while it is ftruck or thrafhed out by the pieces of wood SSSS, fixed in the cylinder DD, and projecting three inches from its furface. This cylinder is made with ftrong arms, on which are fixed the pieces of wood, and cafed round with narrow inch deals; the whole fecured from flying off by ftrong iron hoops furrounding them at each end; the former are covered with plate iron, to prevent their wearing. Thefe, when they ftrike the corn, move in an upward direction RE, with great velocity, and throw the corn as it is thrafhed, and the ftraw as it leaves the fluted rollers, againft the circular rake KK, and upon the wire fkreen G, from whence the ftraw is taken by the rake, and delivered upon the floping board L, down which it flides to the floor N; while the corn paffes through the fkreen G into the hopper H; and from thence to the inclined board I; but in falling from H to I a ftrong current of air, raifed by the fanners FFF, blows the chaff over the floping board O, and the light corn againft it, which falls into the fpace P, and the chaff into M, while the good grain flides down the inclined board II, to the floor at Q, from whence it is taken and put into a fecond winnowing machine, in which are placed proper riddles to fuit different kinds of grain. This fecond machine is moved by a rope going over a pulley, fixed in the axle T, and is fet a-going, or ftopped, at pleafure, by a ftretching pulley, as occafion may require.

But where the fituation will admit of the board II being placed about four feet from the floor, the fecond winnowing-machine may be placed directly under it, and fave the trouble of lifting the corn. The whole is put in motion by an overfhot water-wheel fourteen feet diameter, which makes from five to fix revolutions per minute, according to the fupply of water; on the axle of this water-wheel is fixed a large fpur-wheel *aa*, of 160 cogs ($152\frac{3}{4}$ inches diameter), which drives a caft-metal pinion *b*, of 16 cogs (15,28 inches diameter), on the axis of which is placed another fpur-wheel *c*, of 63 cogs (60,1 inches diameter), that drives the caft-metal pinion *d*, of 16 leaves, (15,28 inches diameter) on the axis of which is fixed the cylinder DD, (four feet diameter, and five feet long) with the four projecting pieces of wood, SSSS, that thrafh the corn as defcribed above. The large fpur wheel *a* alfo drives the light cog wheel *e*, of 63 cogs (60,1 inches diameter), fixed on the axis *k l* of the rake for taking away the ftraw.

The rollers are moved by the pinion *b*, of 16 leaves, working into the flight caft-metal wheel *f*, fixed on the iron axis *ii* of the lower roller, on which axis is alfo fixed a fmall pinion *g*, of 8 leaves, working into another, *h*, of equal number, fixed on the axis of the upper roller, which gives the two rollers an equable motion for taking in the corn. This axis is fixed into the upper roller, either by an univerfal joint, or with a fquare tapering end, to allow the upper roller to rife and fall, according as the corn is fed-in thicker or thinner; and the concave board RE is hung on a bolt, to allow it to rife and fall with the roller.

When the rollers are required to move ſwiſter or ſlower, they may be driven very conveniently from the end of the axle of the rake, by fixing a caſt-metal *faced wheel* on it, with three rows of cogs, (8, 10, and 13) working into a ſhifting pinion of 8 leaves, fixed on an iron axle; at the other end of which is put a ſmall *bevel* wheel of twelve teeth, working into another of eight teeth on the end of the axle of the lower roller. The fanners are moved by a croſſed rope, paſſing over a pulley T, 10 inches diameter, fixed on the axis of the cylinder, and another V, of 8 inches diameter, on the axis of the fanners. The rollers take in nearly 300 inches of corn per minute with a medium quantity of water.

w x and *y* explain ſeparately the manner in which the ſmall wheels are attached.

This machine was found to anſwer well at Chillingham by Mr. Baily.

Fig. 2. Exhibits another thraſhing machine conſtructed on a different principle.

Fig. 3. Repreſents the plan of it.

CHAFF CUTTER.

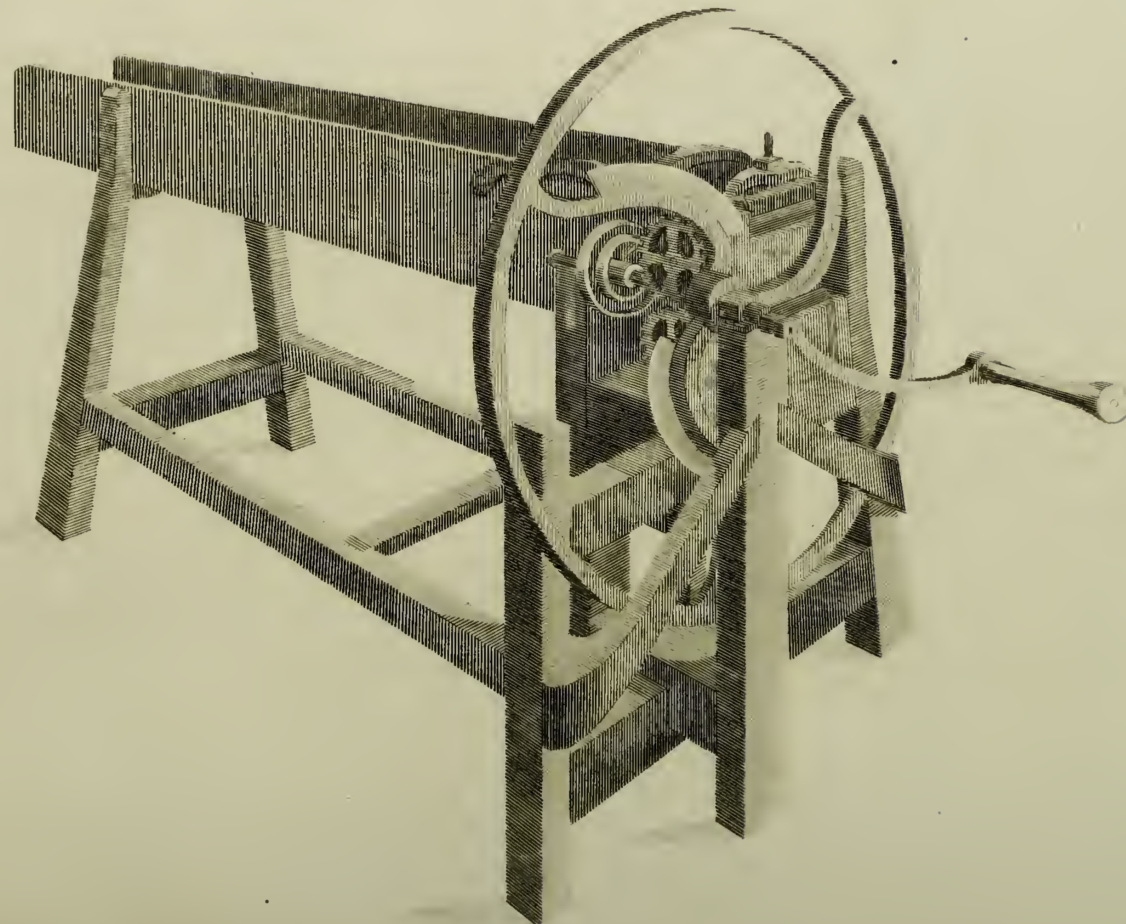


PLATE XV.

Chaff-Cutter.

[*To face Page* 40.]

THIS figure reprefents Mr. M^c Dougall's Patent Chaff-cutter, which muft be confidered as one of the moft ufeful inftruments of the kind ever invented. In this machine the inventor has been particularly careful fo to conftruct it, that, in cafe it fhould be accidentally broken, it might be eafily repaired by any common mechanic. The fubftance to be cut into chaff may be preffed as hard as the workman choofes, by fimply placing a weight nearer to the end of the lever. But the chief excellence of the inftrument confifts in Mr. M[c] Dougall's having judicioufly applied a fpiral groove in the room of the endlefs fcrew, commonly ufed by other agricultural inftrument-makers; by means of which he has in a great degree got rid of friction; and the lever may rife to any height, without putting the machine out of work.

NORFOLK & SUFFOLK HORSE RAKE.

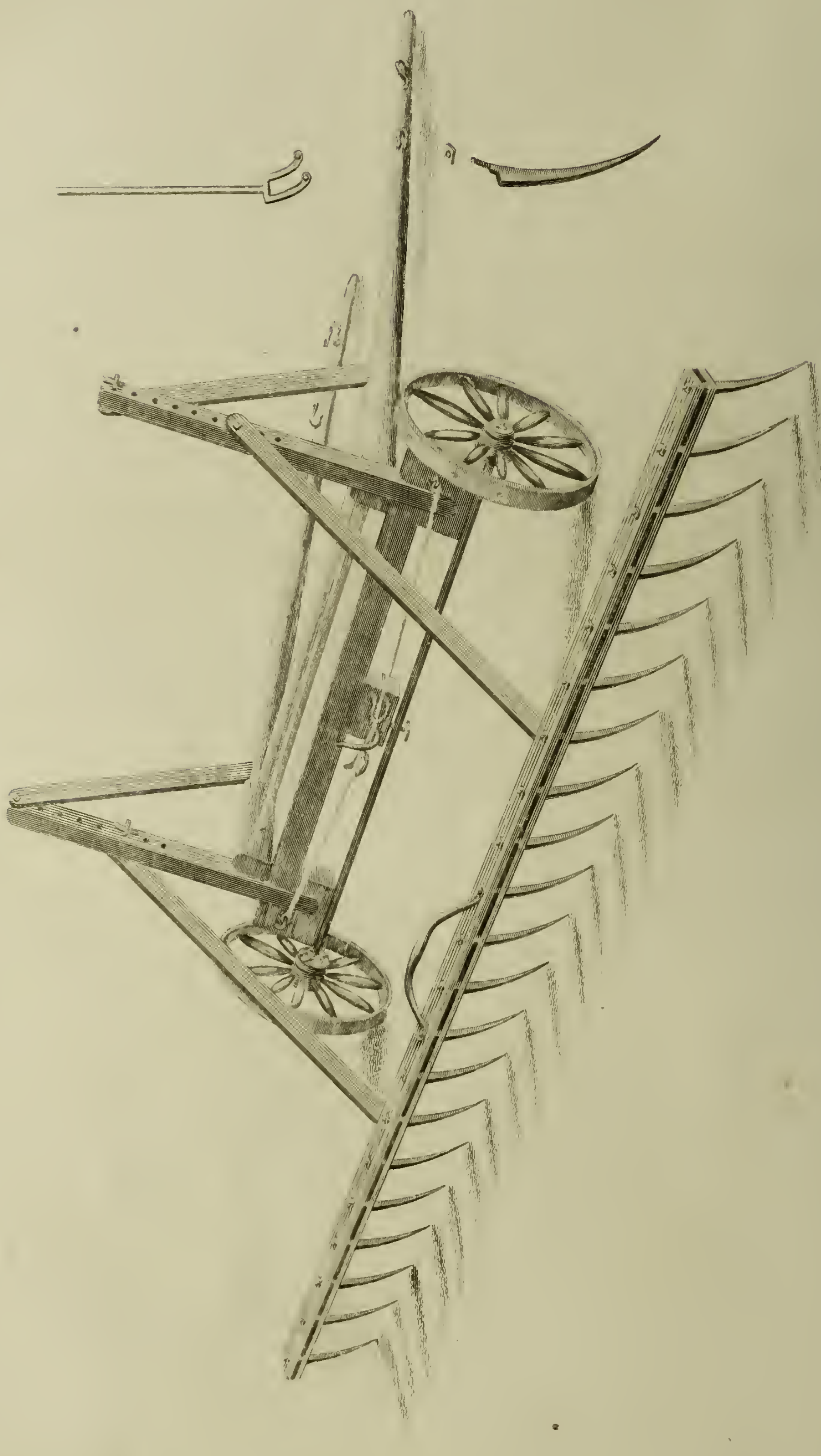


PLATE XVI.

Norfolk and Suffolk Horfe-Rake.

[*To face Page* 40.]

REPRESENTS the Norfolk and Suffolk Horfe-Rake: an ufeful implement, much employed on the large and middling-fized farms in thofe diftricts, and extending itfelf into others. It is made ufe of for barley and oats in the place of the hand-drag or *dew-rake*, fo named from being chiefly employed while the dew is upon the ground, before fome other fort of harveft work can be undertaken. A man and horfe, driven by a line, are capable of clearing from twenty to thirty acres in a moderate day's work, difpofing the grain in lines across the field by lifting up the rake, and dropping it from the teeth without the horfe ftopping. It is recommended by Mr. Young. The price is from four to five pounds.

CARTS and WAGGONS.

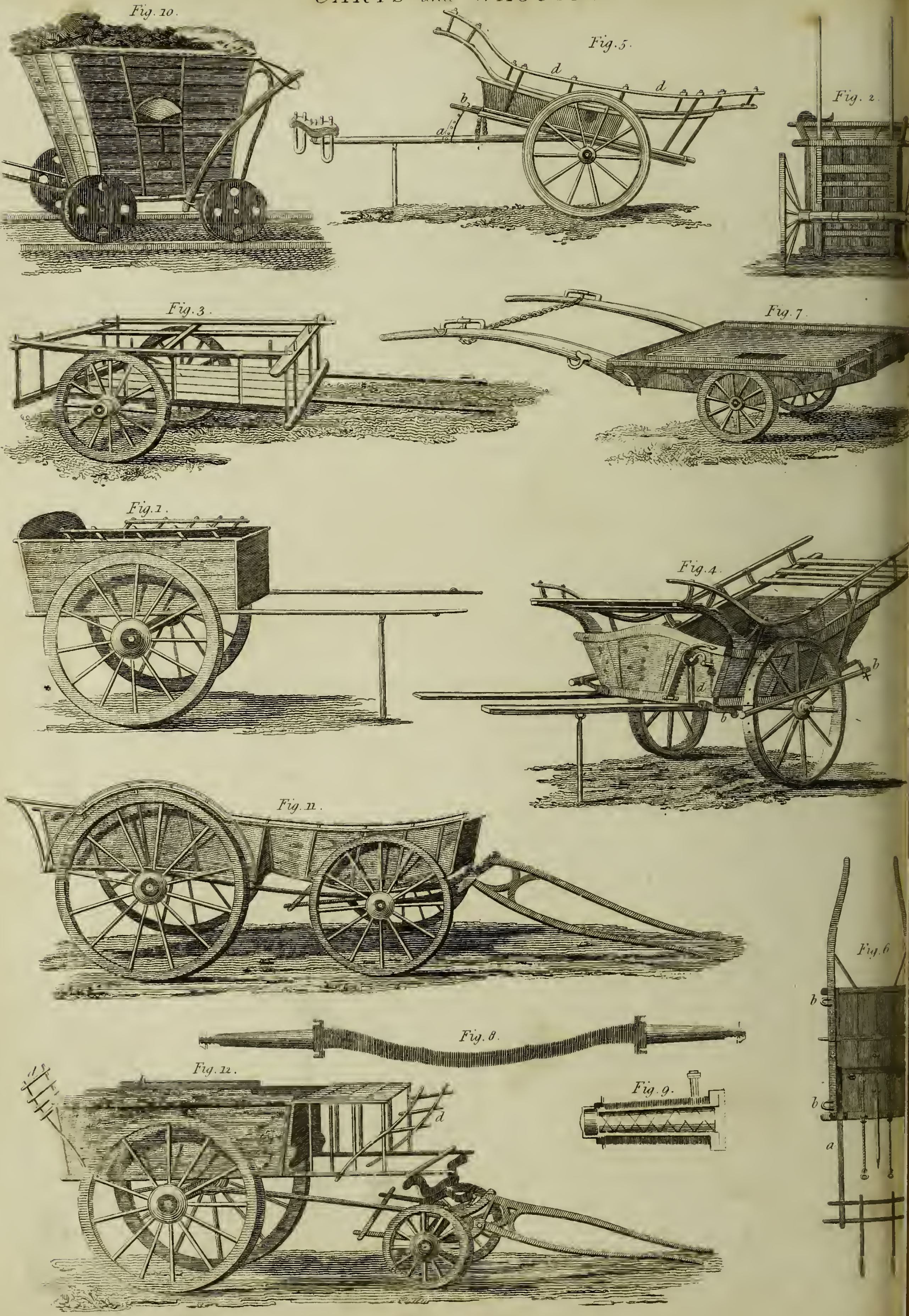


PLATE XVII.

Carts and Waggons.

[*To face Page* 40.]

At *Fig.* 1. is reprefented a common light one-horfe cart for various ufes.

Fig. 2. A clofe fingle-horfe cart, ufeful for conveying manure or other fimilar purpofes: it is fometimes termed a *coup-cart*; the body refting upon a fort of frame, by which contrivance the contents can be readily difcharged.

Fig. 3. Is a cart made ufe of in fome northern diftricts for conveying hay and grain in the ftraw, or any other bulky materials, where only one horfe is employed.

Fig. 4. Is a front view of a *Drag-Cart* recommended by Lord Somerville; it is drawn by a fingle horfe in fhafts. The too great velocity of the cart, in defcending fteep hills, is counteracted by a friction-drag or bar, *b b*, fixed behind by a chain and before by a toothed rack, *b d*, which catches on a ftaple, by which the preffure is regulated by the driver. The pofition, or centre of gravity of the load, is alfo regulated by a toothed rack fixed in the front of the cart at *c*.

Fig. 5. Is a fide view of a cart of this fort, defigned for oxen, the friction-drag being removed. In this a more fimple method of adjufting the centre of gravity of the load is adopted, as feen at *a b*, by the curved iron with holes in it for receiving a pin to hold it at any height required. *c*. A fmall chain to hold the cart from going too far back in fixing it; *d d*, upper part of cart for containing bulky loads.

Fig. 6. Reprefents the body of a cart which can be enlarged occafionally for bulky loads by means of the flides *a a*. The fides alfo put on and take off at pleafure, as fhown by *b b*, &c.

Fig. 7. Exhibits a view of the *Quarry-Cart*, a ftrong low cart for the loading and carrying of heavy ftones, and great weights of other kinds.

Figs. 8 *and* 9. Reprefent an axletree and box conftructed by Mr. Rowntree, which run light and retain their oil perfectly.

Fig. 10. Is the reprefentation of a waggon employed in the collieries for conveying coals.

Fig. 11. Is a reprefentation of a light waggon much ufed in Berkfhire: It is valuable, from its lightnefs, for harveft and other fimilar purpofes.

Fig. 12. Is another waggon, which partakes, in fome degree, of the properties of the cart and waggon, whence it has been appropriately denominated *Hermaphrodite*. The pair of fore-wheels and fhafts, as *a a*, are occafionally attached to a common cart, *b b*, by a pole connected with the axle, to which are added the ladders *d d*. This is a light, cheap, and convenient carriage, and will carry nearly as much hay or ftraw as the above waggon.

SECTION II.

Farm-Houſes and Offices.

FARM BUILDINGS—Too little Attention in the Conſtruction of—Facility and Diſpatch of Buſineſs connected with Form and Arrangement of—Commodious Diſtribution of, neceſſary—When not the Caſe, much Time loſt in the Conveyance of Materials—Size of, proportioned to that of the Farm—When of the grazing Kind few Buildings neceſſary—Theſe chiefly of the cheap ſhed Kind—Permanent Roofs moſtly advantageous—Expence ſaved by Walls with occaſional Coverings—This Plan only recommended in particular Caſes—Different Sorts of Sheds neceſſary for different Kinds of Cattle—Cool ones for Store Cattle—Warm ones for Feeding Stock—Different Accommodations neceſſary for Dairy Farms—Cow-Houſes large—Conveniences for the various Operations of the Dairy—For Corn Farms Buildings more numerous—Calculated to ſuit different Purpoſes—Stables ſufficiently large—Cow and Feeding Houſes adapted to Number and Kind of Cattle—Barn and Granary ſufficiently large—Where Thraſhing-Machines are erected need not be ſo extenſive—Conveniences for young Animals of different Sorts—Horſes—Cattle—Hogs—Poultry.—FARM HOUSES—Dimenſions of, regulated by Size of Farm—Should be airy and commodious—Ground-floor Plan—Parlour—Kitchen—Back Kitchen—Cloſets for various Articles—Dairy—Pantry—Cellar—Divided above into Lodging Rooms—Theſe large for the Sake of Ventilation—Windows more outwards in the Walls advantageous—Floors of, raiſed a Foot or more—Hip-Roofs preferable to Gable-Ends—Thickneſs of Walls according to Materials—When thin, eaſily penetrated by the Sun or Cold—Should be of good Thickneſs—Principal Objects in, Conveniences and Cheapneſs.—BARNS—Size and Conſtruction of, various—Where Thraſhing-Machines and Stacking are in Uſe, large ones unneceſſary—Dimenſions larger where the Flail, and Houſing Grain, are practiſed—Slides neceſſary for the Admiſſion of Air—Conſtruction of Floors—Beſt of Oak Plank—Clay and other ſimilar Kinds of Floors liable to crack and break up—When formed of Plank, ſhould be ploughed and tongued, and have a Foundation of Brick-work—More ſecure and freer from Damps than when nailed to Sleepers—Floors of Brick nearly equal—Thraſhing Floor—Twelve by eighteen Feet a good Size—Addition of Flues or Drying-Floors uſeful—Cow-Houſes, or other Offices, may frequently be provided on the Ground Floors—This Method has various Advantages—Leſs expenſive—Saves Room—Grain more ſecure—Chamber Barn Floors—Eaſier to thraſh upon—Pitching-Holes uſeful in every Form of Barn—Unloading in the Barn more expeditious.—GRANARIES—Should be firmly built—Have extenſive Flooring—Contrived to avoid Labour—Effected by particular Conſtruction of Floors—Free Ventilation by latticed Windows

—Spouts or Ventilators on the Top—A ſquare the beſt Form—Neceſſary to be placed on ſhort Poſts or Pillars of Stone—Should be lined with Boards cloſely joined together—Outſide covered with Weather-boarding—In common Granaries, Attention not neceſſary to all theſe Points—Need not be ſo ſtrongly built—Moſt proper Situation in the Barn where houſing Grain is not practiſed—Machinery for raiſing the Corn neceſſary.—STABLES—Elegance not requiſite in—Comfortable and convenient ones neceſſary—Should be ſo contrived as to preſerve nearly an Equality of Temperature at different Seaſons—Muſt be provided with proper Drains for the Removal of Moiſture—Moveable Shutters, as Windows, ſave Expence—Racks and Mangers—Economy and Convenience in Conſtruction of—Large ones diſadvantageous—Should have a more perpendicular Poſition than uſual—Placed conveniently in Niches in Walls—Sparred at Bottom to admit Hay-Seeds—Conveniences to collect them uſeful—Hatches ſave Time in feeding—Mangers need not be the Width of Stalls—Small Boxes convenient for—Cheap Method of forming Stalls and Racks—In this Way ſparred at Bottom—Hay-ſeed Box neceſſary—Single Stalls better than double—Attention neceſſary in paving Stables—Should approach to a Level—Moiſture removed by ſmall Middle-Drain—All the Drains to empty into a large one—Stall Drains covered by perforated Oak Planks—Main Drains placed at Ends or Bottoms of Stalls—Shallow open Drains leſs expenſive—Pavement of Stalls ſhould have very ſlight Inclination to Drains—Advantages gained by this Conſtruction of Stalls—Size of Stalls—Five Feet a good one—Diviſions of ſhould be high—For Stallions and young Horſes ſparred to the Top—Or divided by Doors hung to back Poſts of Stables—Latter Method uſeful for Mares and Foals—Harneſs Place near the Stable neceſſary—Situation for Corn-Bin—When placed above ſhould feed by a Spout in Stable—This Mode has Advantages.—COW AND FEEDING HOUSES—Nearly ſimilar—Calf-Pens in them ſometimes—A Plan not to be adopted—Better at a ſmall Diſtance—May be contrived to ſuit either Purpoſe—In the Form of ſingle or double Sheds—Muſt be capable of free Ventilation—Require little Labour in cleaning—Have Drains to keep the Cattle dry—Free Circulation of Air neceſſary in—Without it Cattle liable to Diſeaſe.—Sheds open behind ſometimes uſeful—Air-Holes in Roofs occaſionally neceſſary—Windows in Gable-Ends frequently uſeful—Advantages of ſuch Means—Feeding of Animals promoted in this Way—Modes of Conſtruction—Circumſtances to be attended to in—Common Method injudicious—Feeding from Holes without—Objections to—Moſt convenient Plan of, in ſingle Sheds—Double ones more economical and uſeful—Leſs Extent of Building, neceſſary in—Leſs Deſtruction of Fodder—Room over uſeful in all Sheds—An intelligent Feeder's Opinion on—Double Sheds not ſuppoſed ſo advantageous—Rooms over prejudicial—Plan recommended by him—Room in the Middle of, neceſſary—Keeping Cattle clean and dry, Uſes of—Contrivances for leſſening Labour eſſential—Means of doing which—Attention to paving Stalls neceſſary—This frequently not done—Double Stalls uſeful—The Expence of greater—In many Caſes unneceſſary—Conveniences for Food and Water neceſſary—Drains and Reſervoirs ſhould conſtantly be formed.—CALF-PENS—Situation of—Near Cow-Houſe—Mode of laying Floors of—Diſagreeable Effluvia thus avoided—Moveable Diviſions in, uſeful—Troughs and Racks ſometimes neceſſary—Food more equally diſtributed by them—In general not requiſite.—DAIRIES—Advantages of good ones—Are of different Kinds—Conſtruction of each—Proper Situation of—Moſt advantageous covering of—Thatch uſeful for—Stone Walls always preferable—Proper Height of Ceilings of—High Win-

dows neceſſary—Should have Frames with Gauze ſtretched on them—Utility of—Floors of—Beſt Sort of Materials for—Proper Manner to be laid—Well near neceſſary—Mode of fitting up—Veſſels for —Of different Materials—Lead—Marble—Slate ones made by Mr. Hind at Swithland, near Leiceſter—Firſt muſt be kept clean—Plugs and Cocks neceſſary for Coolers—Large Cock for Water requiſite—Flues for conducting Heat ſometimes neceſſary in them—Circumſtances to be attended to in Ceilings and Walls—Churning-Room near the Milk-Houſe—Fire-Place neceſſary where Utenſils are kept—Stone Slabs or Strips of Wood neceſſary on outſide of—Smoking of Chimneys in, prejudicial—Cheeſe-Dairy—Milk-Houſe for nearly ſimilar—Here ſometimes uſeful to have Milk-Shelves—Preſſing or Scalding Houſe on ſame Plan as for Churning—Should always have a good Preſs in—Salting-Room—Laid with Flags—Strong Table and Shelf neceſſary—Cheeſe-Room—Beſt over the Dairy —Commonly above Cow-Houſe or Kitchen—Reaſons of.—SHEDS—Highly convenient—Modes of conſtructing them—Uſeful for various Purpoſes.—STRAW-HOUSES—Frequently uſeful—Save Straw and Time—Prevent Litter.—ROOT-HOUSES—Neceſſary to the Supply of Winter Food—Roots or other Vegetables.—POULTRY-HOUSES—Circumſtances in Conſtruction of.—HOG-STIES—Mode of conſtructing them—Troughs contrived to prevent Waſte of Food—Boilers for preparing Food, ſometimes requiſite in.—COAL AND WOOD HOUSES—Moſt uſeful Conſtruction of.—WORK-SHOPS—Utility of.—TOOL-HOUSES—Circumſtances to be attended to, in.—STORE-ROOMS—Situation for—Various Uſes of.—FARM SERVANTS' ROOMS—Neceſſary on large Farms—Advantages of—Beſt Situation for—Ground-Floors of Stone or Brick—Upper ones of Plaſter or Brick —Mode of forming them—Arrangement of Beds—Free Circulation of Air in, neceſſary.—PIGEON-HOUSES—Should be large and roomy—Beſt Situation of—Form of, not material—Sort of Covering neceſſary for—Should be ſecure againſt Vermin—Conſtruction of, when built ſeparately—May have Sheds under them—Objections to Wood-Coats—Entrances of ſhould face the South—Large Holes improper—Weather-Boards above them neceſſary—Methods of forming the Neſts.—Forms of —Sheds the beſt—Proper Situation of.—CONVENIENCES FOR PREPARING CATTLE-FOOD—Advantages of in feeding Animals.—STEAM BOILERS—Uſeful in various Ways—Deſcription of—Other Contrivances propoſed---Uſeful for other Purpoſes.---CORN CHESTS---Neceſſary and economical---Small Tub ſometimes ſufficient---Beſt Conſtruction of---That of the Granary uſeful on large Farms.---CORN STANDS---Conſtruction of, various---Beſt Mode of---Form of the Duke of Bedford's at Woburn Abbey---Peculiar Circumſtances in the Formation of---Materials moſt proper for---Slates or Flags ſometimes uſed for Bottoms of---Not neceſſary when the Foundation is well laid---This kind of Stand uſed by Mr. Bakewell.—BEE STANDS.---FARM HOUSES AND OFFICES---Situation and Arrangement of---Moſt economical in ſaving Labour---Proper Situation of---Near the Centre of Farm---A Square the moſt proper—Offices erected on expoſed Sides of---Not attended to in building Farm-Houſes---Theſe ſhould be at a Diſtance from Offices---Sometimes ſuch as to overlook the Operations going on---Muſt be adapted to the Buſineſs---Nature of Ground frequently points out Situations---General Obſervations on the Expence of Farm Buildings.—Eſtimates of.

IN the conſtruction of farm-houſes, and other buildings neceſſary for the economical and advantageous management of farms, too little attention ſeems hitherto to have been paid, conſidering the great practical importance of ſuch objects. It is obvious,

however, that the facility and convenience of carrying on different operations muſt greatly depend on the judicious form and arrangement of ſuch erections. By the commodious diſtribution of ſuch buildings, ſervants are enabled to perform more labour, and with greater eaſe to themſelves; as where offices are injudiciouſly placed, much of their time muſt, of neceſſity, be loſt in the conveyance of different articles, ſuch as fodder, ſtraw, &c. from one place to another.

The ſize of farm buildings ſhould in general be proportioned in ſome meaſure to that of the farm, and their conſtruction be regulated by its nature and ſituation. Where the farm is merely a grazing one, fewer buildings are required, and theſe are chiefly of the ſhed kind, which may be formed in a cheap manner, of ſuch materials as are neareſt at hand, or can be eaſily procured. In ſuch caſes the ſheds ſhould, however, always have permanent roofs, except they are built in the fields for ſummer uſe only. On thoſe grazing farms where the cattle are only houſed during the winter, or where a greater number of buildings are employed in winter than in the ſummer, much expence in roofing ſuch ſheds may frequently be ſaved by erecting walls only, and fixing merely temporary coverings to them for the ſhelter of the cattle; or by having poſts framed, and placed in ſuch a way as to ſupport hay-ricks, or any other ſort of rick not to be removed during the winter. By this means a warm roof is afforded, and a convenient ſituation given for the ſtacks. This, however, from its being a paltry and ſlovenly method, is only to be had recourſe to under particular circumſtances, as where a better ſort of cattle ſhed cannot with propriety be built.

On ſuch ſorts of farms, different ſorts of ſheds ſhould conſtantly be provided for different kinds of cattle: where they are intended for ſtore ſtock only, they ſhould be open on one ſide, as the cattle ſhould be kept cool, otherwiſe they are apt to take cold when they are turned out, which they ſhould always be every day when the weather is tolerable; but if they are intended for feeding cattle, they ſhould be made much warmer, as in that caſe the cattle will thrive faſter, and there is no neceſſity for turning them out, ſo that the danger of their taking cold is avoided.

Different accommodations from theſe will be neceſſary for dairy-farms, they being moſtly compoſed partly of grazing and partly of arable land. On theſe the cow-houſes ſhould be ſo regulated as to ſuit the number of cows that can at any time be kept; and ſuch other conveniences ſhould be provided as are proper for the dairy buſineſs, whether they be managed as cheeſe, butter, milk, or ſuckling farms. For ſuch farms ſmall ſtables and barns are, in general, ſufficient.

And for the arable or corn farm, as partaking in general of both the other ſorts, the offices and buildings ſhould not only be much more numerous, but calculated to

ſuit the various purpoſes of each. The ſtables ſhould be ſufficiently large and convenient, for the accommodation of ſuch a number of horſes as may at any time be employed in the labour of the farm ; and the cow and feeding houſes adapted to the quantity and kind of cattle kept or fed. The barn and granary muſt alſo be proportioned to the extent of ground under arable cultivation. Where thraſhing-machines are to be erected, the ſize of the barns need not be ſo great as in other caſes; as neither the height neceſſary for the flail, nor room for a large quantity of corn in the ſtraw, are required. Beſides, theſe machines not demanding much elevation in the buildings where they are placed, a granary and ſtore-room may often very conveniently be made above them, which cannot be done where the barn is required to be high.

On this kind of farm convenient buildings ſhould alſo be prepared for the breeding and management of young animals of different ſorts, ſuch as horſes, cattle, hogs, poultry, &c.

FARM-HOUSES.

The dimenſions of the farm-houſe, like moſt of the other buildings, ſhould, in a great meaſure, be regulated by the extent of the farm. It ſhould be neat, airy, and have ſufficient accommodations both for the family of the farmer, and the buſineſs that is to be performed in it. On the ground-floor there ought, at leaſt, to be a good parlour and kitchen, with back kitchen, which may ſerve alſo for a bake-houſe and brew-houſe, with cloſets and other convenient places for depoſiting different articles : and likewiſe a dairy, pantry, and a proper place for the purpoſe of a cellar.

The upper part may be divided into lodging-rooms or bed-chambers, which ſhould be rather large, in order that the circulation of air may be free and unreſtrained. The windows are better to be tolerably large than ſo ſmall as they are commonly made, and the ſaſhes placed nearer the outſides of the walls ; for it is evidently a miſtake that they are better preſerved from the effects of the weather by having them ſet ſo much within the wall as is uſually the caſe, as the wet cannot be ſo readily dried up. By not properly attending to theſe circumſtances. the appearance of houſes of this kind are frequently rendered gloomy and unpleaſant. It will alſo be of great advantage in reſpect to health and cleanlineſs, to have the ground-floors raiſed ſixteen or eighteen inches above the ſurface of the ground. The kind of roof ſhould be determined by the expence of materials and other circumſtances ; but hip-roofs, with vents within the buildings, as being cheap, are,

probably, in general to be preferred to thofe where gable ends are had recourfe to. It is juftly obferved by a late author, that hip roofs require no more materials, while gable-ends caufe more expence of building, and an unneceffary accumulation of weight upon the end walls; and that vents made within-fide of the houfe are not only lefs liable to fmoke than when in an outfide wall, but contribute much to keep the houfe warm, by acting in fome manner as flues, and diffufing heat more or lefs throughout the whole houfe *.

The thicknefs of walls, as well as many other circumftances, muft depend on the eafe and convenience of procuring materials: where rough ftone walls are made, the thicknefs may be about eighteen inches or two feet; but where the ftones are good and properly formed for building with, or where bricks are employed, they may be made much thinner; it fhould, however, be remembered, that when they are too thin, they are readily penetrated by the heat of the fun in fummer, and by cold in winter. Such houfes ought, therefore, always to be built of fuch a thicknefs as to prevent the effects of thefe as much as poffible.

In the conftructing of houfes for the purpofes of farming, it is evident that confiderable latitude muft be given, but, as architectural ornaments are not much wanted, the principal points to be attended to would feem to be thofe of providing fufficient conveniences without incurring great expence. Such buildings fhould be cheap and fimple in their form, and have a regularity of appearance.

BARNS.

It is obvious from what has been already advanced, that the fize and conftruction of barns muft be varied in fome meafure, according to the cuftoms and fituations of the places where they are to be erected. Where thrafhing machines, and the practice of ftacking, are properly held in eftimation, large barns are quite unneceffary; but on fmall farms, and where a preference is given to the ufe of the flail, and the ftoring of the crops in barns inftead of ftacks, they fhould be of confiderably larger dimenfions, in order, not only to admit the neceffary quantity of grain to be depofited in them, but to allow fufficient room for the free ufe of the flail. In fuch cafes they fhould not, perhaps, be lefs than eighteen or twenty feet wide, with height and length proportioned to the quantity of materials that are to be ftowed. Air fhould likewife be pretty freely admitted into them on different fides by means of flides or other contrivances. The conftruction of the floors fhould be par-

* Beatfon's Paper in Communications to the Board of Agriculture, vol. I.

ticularly attended to, in order that they may be firm and dry : the firſt purpoſe is probably beſt obtained by making them of good oak plank; floors formed of clay, and other ſubſtances of a ſimilar kind, being liable to crack and be broken up by the different operations that are performed upon them. When floors are made with planks, it is a good method to lay them upon a foundation of bricks, and unite the different planks by ploughing and tonguing. In this way floors are made more ſecure, and freer from damps, than where they are nailed down to ſleepers. The ſize of the thraſhing-floors of barns muſt vary according to circumſtances; but twelve feet by eighteen would ſeem in general to be a good proportion. It has been obſerved to me by an experienced agriculturiſt, that next to oak planks, and nearly equal for thraſhing floors, are bricks made of good tempered clay well burned, made four inches thick, and laid edgeways with well-beaten mortar. The addition of flues and floors for the purpoſe of drying might alſo be ſometimes conveniently employed, and would frequently be found advantageous in moiſt and damp ſeaſons.

Where the ſituation of the ground and other circumſtances will permit, cow-houſes and other farm offices may be provided on the ground-floors, the barns, hay-chambers, &c. being above. The advantages of this mode of conſtruction are, that it ſaves much expence in buildings, and occupies but little room, while the grain is in leſs danger of being ſpoiled by the introduction of dirt or other hurtful ſubſtances from the farm-yard, and more ſecure from the depredations of hogs, poultry, &c. Chamber barn-floors are alſo ſaid to be more convenient and eaſy for thraſhing upon. Theſe kinds of barns can only, however, be adapted to ſmall farms, and then perhaps may often be ſaid to be attended with inconvenience.

In whatever manner thoſe barns are built that are intended for containing large quantities of different crops, they ſhould conſtantly be provided with convenient pitching holes for houſing them at, as by this means the danger of injuring the floors by heavy carriages being drawn upon them, is avoided, and there is not any neceſſity for thoſe large and expenſive doors that have been in common uſe : little injury will, however, be done to the floors by drawing the loads of grain upon them, when they are kept well littered with ſtraw ; and a man will unload nearly two loads of grain, when drawn into the barn and unloaded upon the mow, while he could unload one at a pitch-hole.

GRANARIES.

The great object in theſe buildings being the preſervation of a large quantity of grain in a narrow compaſs, they ſhould not only be ſtrongly built, but be provided

with a great extent of flooring on which the corn may be ſpread; and as frequent ſtirring or turning is neceſſary for the ſafety of the grain, it is obviouſly of much importance to have them ſo contrived, that a great deal of the manual labour attending ſuch operations may be avoided. This is done, in ſome caſes, by having them conſtructed with different floors placed in ſuch ſloping directions that the corn has a tendency to the centre, and is let out by means of ſliding ſhutters; in others the ſame advantage is gained by a number of hoppers, ſituated in ſuch a way as to allow of the grain being moved by merely drawing a ſlider at the bottom of the granary. Sufficient ventilation, which is highly neceſſary in theſe buildings, is, in ſome inſtances, provided by having ſmall windows ſtrongly latticed and covered with wire, as well as ſtout ſhutters cloſe to the ceilings, and in others a free circulation of air is given by means of a number of air-holes and ſpouts, diſpoſed in horizontal poſitions acroſs the buildings. Where it is neceſſary that the air ſhould likewiſe paſs upwards, that direction may be readily given it by having a ventilator on the top of the granary.

The moſt convenient form for buildings of this ſort is probably that of a ſquare, the ſize of which may be about fourteen feet. They ſhould when built ſeparately ſtand on a ſufficient number of ſtrong poſts, or pillars of ſtone, about four or ſix feet above the ſurface of the ground, having very ſtrong wooden frames, the inſides of which muſt be filled up with bricks. The girders, joiſts, and flooring, ſhould be firm and ſtrong, that they may not give way by the great weight of the grain. The whole of the inſide is rendered the moſt complete, by being lined with dry oak, or good deal boards, cloſely jointed together, and the outſide covered over with ſtrong weather-boarding, well nailed to the timber-work of the frame, and properly payed over with pitch or tar-varniſh.

But in conſtructing granaries where the accommodation of the farm is the only object, it is quite unneceſſary to pay attention to all theſe circumſtances, as a large quantity of thraſhed grain is ſeldom kept. Neither the ſame ſtrength or expence of building is required as for thoſe in which large ſupplies of corn are depoſited. It is proper, however, in moſt caſes, that a place of ſafety for corn ſufficient for the reception of one half of the annual produce of the farm ſhould be provided. Where the cuſtom of houſing grain prevails, there is ſeldom room enough left for erecting a granary within the barn; but where that practice is not regarded, and eſpecially where there is a thraſhing-machine, the beſt and moſt convenient ſituation for it is the barn; proper tackle and conveniences for hoiſting up the corn being provided.

STABLES.

In the conftruction and fitting up of ftables for farm-horfes, it is not neceffary to attend fo particularly to elegance, as in thofe which are intended for the reception of horfes of other defcriptions. It is, perhaps, fufficient to provide them comfortable and convenient habitations; working horfes fhould not, however, be kept in fuch low dirty hovels as they frequently are, as nothing tends fo much to the keeping of thefe animals in health, as their having dry, clean, and well ventilated ftables. They fhould, therefore, be conftructed in fuch a manner as to keep out the fevere cold of winter, and the intenfe heat of fummer, and be provided with proper drains for conveying away every kind of moifture and naftinefs. The number and fize of the windows fhould be proportioned to the extent of the ftable, and be fo contrived as to open and fhut at pleafure. When it is neceffary to fave expence, fhutters may be adapted to, and fufpended in the windows by iron-pins, on which they may be turned as occafion requires.

In the contriving of racks and mangers, regard fhould be had to economy and convenience. The common and too general mode of making them extend quite acrofs the upper end of the ftall, is not only a bad, but by no means a cheap method of conftructing them. Befides, in order to fave trouble, fervants are extremely apt to ftuff racks full of hay, however large they may be; from which various bad confequences proceed, and much hay is wafted and deftroyed by being either pulled down and mixed with the litter, or trodden under the feet of the horfes.

The pernicious effects refulting from the practice of fuffering horfes to be continually ftuffing themfelves with hay, are well known to thofe who are acquainted with the proper management of fuch animals, under whofe directions they are never allowed to have much hay in their racks at a time. There is alfo another difadvantage in this plan of fitting up ftalls, efpecially to farmers, as it ought to be their object to preferve every thing;—the hay-feeds are totally loft, which if good, and carefully fecured, might be of great utility and value. By the racks having fo much inclination outwards, the feeds are alfo extremely apt to fall into the horfes' ears and eyes, which often produce difagreeable effects. From thefe confiderations it would feem that racks fhould have a more perpendicular direction than is commonly given them, not having a fpace of more than fourteen or fixteen inches from the wall; the bottom fhould alfo be fparred, in order to let the feeds fall down below, whence they may be removed by a fliding fhutter or fmall door. The fame advantages may

alfo be obtained by leaving niches in the walls for the racks, on which plan the fpars will be equal with the infides of the walls. If the niches and racks be made in the middle of the ftalls, two feet, or two feet and a half wide, will in moft cafes be fufficient; they fhould, however, be carried down low enough to admit of a fmall box or drawer being placed under them, for the reception of the hay-feeds. Racks of this fort may likewife be placed in the corners of the ftalls, and be made in fuch a way as that one nich may ferve two ftalls. They may alfo be placed in the angles of the ftalls without having any nich, and be made of a femicircular form. But in whatever way they are made, there fhould conftantly be a divifion betwixt them, which is probably beft made of deal. By this means the farmer will be able to know, with precifion, what each horfe eats, which cannot be done in any other way. Where the racks are put in the corners of the ftalls, it may, perhaps, be more advantageous to have them ftraight than circular; but in whichever way they are formed, the farmer fhould always have a hatch fixed for each ftall, as by that means a great deal of time may be faved in feeding his horfes.

It is equally unneceffary in the making of the manger to have it the fame width of the ftall; as a box or drawer fixteen or eighteen inches long, and twelve or fourteen inches wide, will anfwer every purpofe. It fhould be fo contrived that it may be readily taken out and cleaned whenever it is fouled or becomes furred with dirt. With the fixed mangers this can never be done, however they may be daubed by the faliva iffuing from the horfe's mouth during the time of feeding, or the difcharges proceeding from his noftrils when labouring under colds, or other more dangerous diforders.

There is another method of making ftalls, which, as being cheaper and more economical, deferves to be noticed: on this plan the ftable has neither racks nor mangers; the head of the ftall is boarded about three feet from the ground, having a fpace of about two feet from the wall, in which the hay is to be depofited, the horfe pulling his hay from below, inftead of drawing it from above; which is not only more natural, but prevents the wafte of hay, much of which drops down and is loft when the horfe eats from a rack; but, by this method, whatever falls is again received among that from which it was taken. But even on this conftruction it will be neceffary to have the bottom fparred, within eight or ten inches of the ground, and a box, hopper, or hay-manger, and drawer, fo contrived as to receive the feeds of the hay: where there are double ftalls the boxes may be divided in the middle. Single ftalls, where they can be conveniently made, fhould, however, always be preferred as more fafe.

Paving of ftables is a matter of fome importance, though it has been but little attended to: whether the ftall fhould have a flight declivity or be perfectly level, has not, perhaps, yet been fully determined. It would feem, however, to be more natural and eafy for thefe animals to ftand and reft themfelves on a level furface, than on one that is floping, as it is obvious that the tendons, or finews of the paftern joints, muft be kept more upon the ftretch in the latter, than the former cafe. The chief difficulty in refpect to a level ftall has been the conveying away of the moifture. This may, however, be well accomplifhed by paving the ftall quite level, and only leaving a fmall drain in the middle, extending within two or three feet of the upper end of the ftall. It fhould not be more than feven or eight inches wide at top, forming an angle at the bottom. The depth of that end neareft the head of the ftall fhould not be more than three or four inches deep, having as much flope as can be conveniently given it backwards, in order that it may carry the moifture off quickly to the main drain, into which all the ftall-drains fhould empty themfelves.

The fmall ftall-drains fhould be covered with a piece of good ftrong oak-plank, in which a great number of holes are bored, and which is fo faftened as to admit of its being readily raifed up and let down: by this means the drains may be wafhed and kept clean and fweet.

Main drains may be made at the end of the ftalls, or in any other convenient fituation, for carrying off the moifture into the general refervoir. If they are placed at the bottom of the ftalls, they fhould not be clofer to the ftalls than two feet, in order that the ftale of mares may get readily into them, which would not be the cafe if they were nearer, unlefs the pavement behind the ftalls were made to decline a little towards them. Thefe drains need not be more than feven or eight inches wide at the top, but they fhould be covered with plank, in which holes are perforated for conveying away the moifture.

In order to fave the expence of making main drains, a fhallow open drain may be made in the common way, with which the ftall drains may communicate by means of very fmall grates at the ends.

The pavement or floors of the ftalls fhould have a very flight declination from their fides towards the drains, to prevent any moifture ftanding on them; an inch, or an inch and half will, however, be quite fufficient.

From having ftalls conftructed in this way, feveral advantages will be gained; the horfes, by ftanding on a level, will be lefs liable to diforders in the feet and heels, and from the great declivity of the drains the urine will be more readily carried away, and not be fuffered to fpread; and, of courfe, much litter be faved, which is a matter of confiderable importance where ftraw is fcarce.

The fizes of ftalls are different, according to circumftances; but four feet and a half are the leaft they fhould ever be made; five feet is much better. The divifions between them fhould be high, fo that ftrange horfes may not fee each other. And where ftallions are kept, or young horfes required to be left loofe in a ftall, they fhould be fo inclofed as to be incapable of doing mifchief. For thefe purpofes, one or more ftalls may be fparred to the top, or doors provided, which may be hung to the back pofts of the ftable. Where this laft method is followed, the ftalls ferve extremely well for keeping different mares and their foals feparate from others.

Either in the ftables, or very contiguous to them, a place fhould always be provided for the reception of harnefs and other articles of the fame kind; and likewife a fuitable and well-fecured place for a corn-bin. If the ftable be fmall, and it is, of courfe, the moft convenient to have the corn-bin in the room above, it fhould be fo conftructed as that the proper feed may be regulated and received from a fpout in the lower part of the ftable. This method faves much time and trouble in going to the bin, meafuring, &c. as well as in many inftances much corn *.

COW-HOUSES AND *FEEDING-HOUSES.*

As thefe buildings refemble each other in many refpects, they may be defcribed under the fame head. In fome cow-houfes there are, however, an addition of calf-pens, and flight differences in the conftruction of the ftalls. But although the having calf-pens in the cow-houfe may occafionally fave trouble in carrying milk, it is a plan by no means to be generally adopted, as it caufes much uneafinefs to the cows, and prevents their giving their milk properly, or fufficient in quantity. It is a much preferable method to have the calves fo placed, or at fuch a diftance, that the cows cannot be difturbed by their cries, as by thefe means the cows will not only much fooner forget their calves, but feed the better, and afford a larger fupply of milk.

Cow-houfes, or feeding-houfes, by a very little management in building them, may be fo contrived as to fuit either purpofe, as neceffity may require. They may either be made in the form of fingle or double fheds, but the latter is probably the better method, as by that means a great number of cattle may be well accommodated at a trifling expence of building. The principal points to be attended to in conftructing thefe buildings are, that they be capable of free and eafy ventilation; that they require little labour in adminiftering the food and clearing away the excrement;

* Communications to the Board of Agriculture vol.

and that the ftalls be fo contrived as to keep the cattle perfectly dry, airy, and cool, and have convenient and fuitable drains and refervoirs for the reception of urine and dung.

Thofe who have had much experience in the management of cows, know that a free circulation of air is as highly neceffary in thefe houfes as in ftables. In low and clofe buildings, where a great number of cows are put together, they are extremely liable to be difordered by the condenfed perfpiration and fumes arifing from their refpiration, as well as from the cold proceeding from the quick evaporation that takes places in fuch cafes.

In this way cattle are frequently prevented from fattening fo expeditioufly as they otherwife would do. Where many cattle are together, the fheds in which they are kept would, perhaps, be beft quite open behind them, except for feeding cattle, which are well known to thrive fafter when kept rather warmer.

When more free ventilation is neceffary, which is fhown by the wetnefs of the timbers above, it is probably the beft way to procure it by making additional air-holes in the roofs or other convenient places of the buildings. Where there are gable-ends, windows may be made high up in them, with moveable boards fo contrived that they can be opened or fhut as occafion may require. By thefe means advantages are gained, not only in refpect to the health and fattening of the animals, but the duration of the building itfelf; for wood which is frequently wetted and dried in the way we have juft noticed, decays with aftonifhing rapidity.

As any one the leaft acquainted with the animal economy muft know that it is utterly impoffible for fuch cattle as are kept in a ftate of conftant exceffive perfpiration to feed well, and confequently get fat with expedition, which are the circumftances on which the farmer's profit and advantage greatly depend, more attention fhould certainly be paid to thefe matters. An extenfive feeder in one of the midland diftricts, however, affures us that he has, from long experience, always found fuch cattle as feed the quickeft, whether within doors or without, to be thofe which are generally in a ftate of moderate perfpiration.

In regard to the moft convenient plan of conftruction for faving expence in labour, and for allowing of the moft ready and expeditious mode of clearing away the dirt and naftinefs which is produced, there are many things to be attended to, but chiefly thofe of the form and arrangement of the internal parts. It is a very common method to have pofts placed along the fides of the wall at the diftance of about three feet from each other, to which the cattle are faftened; a fpace of three or four feet being left next the wall for the reception of the food. This

is, however, a very injudicious method, becauſe the feeder is conſtantly under the neceſſity of going among the cattle in order to give them their food; except, indeed, where they are fed from the outſides of the building, which is both an inconvenient and tedious method of proceeding. In feeding from without too, through holes made on purpoſe, there are many objections. At ſome periods, as in rainy weather, and when there is a great fall of ſnow, it will be almoſt impoſſible to give them their provender.

The moſt eaſy method to avoid theſe inconveniences in ſingle ſheds, is to leave a ſufficient ſpace before the heads of the cattle for the feeder to go, with ſuch vehicles as contain the food, by which means he will be enabled to diſtribute it with facility. In double-ſheds, which are unqueſtionably the moſt proper, economical, and convenient buildings, the ſame advantages are obtained by making the cattle to face one another, and leaving a ſpace of about four feet as a paſſage for the perſon who feeds them. By this arrangement a leſs extent of building is neceſſary, and much leſs deſtruction of fodder incurred, eſpecially where a loft is provided in the roof for depoſiting the provender, and other purpoſes. This ſhould alſo be done in the ſingle ſheds, and the eaſieſt mode is that of having covers or doors opening by means of hinges without, by which the different articles of food may at once be thrown in from the cart or waggon. In theſe caſes the ſheds ought, perhaps, to be a little higher than they are commonly made, and the inſide be covered above the cattle with boards. But double-ſheds, a very intelligent feeder aſſures me, are not only the moſt improper and inconvenient, but the leaſt economical, and moſt expenſive in their conſtruction; being attended with many inconveniences, and no advantage, that he knows of, except that of ſaving a little, and but a little, room. Sheds for cattle ſhould never, he thinks, have lofts over them, as by that means the cattle are kept too warm and cloſe; and unleſs the floor over them is quite cloſe, which is ſtill worſe for the cattle, the fodder that is laid there is frequently ſpoiled by their breath. He would always recommend ſingle-ſheds open behind, about twelve feet within, including a gang-way of two feet before the heads of the cattle, for the purpoſe of feeding them: three feet, or three feet two inches, he has always found ſufficient ſpace for each beaſt, except they be very large indeed. It is alſo very convenient, he ſays, to have a ſmall room, about the middle of the ſide of the ſhed, with a door into the gang-way, for the purpoſe of getting the hay into from the ſtacks, which ſhould be placed as near thereto as poſſible.

The keeping of cattle clean, dry, and free from diſagreeable effluvia, is not only a buſineſs which demands much attention, in ſo far as it tends to preſerve their health, but which intereſts the farmer in a high degree, from its taking up much

time that might be otherwife employed. It is therefore of the greateft importance to have thefe kinds of buildings fo contrived that they may require as little labour as poffible in removing dung, &c. Thefe things fhould, therefore, particularly occupy the minds of perfons employed in making fuch erections. Where, from fituation and other circumftances, a convenient place can be provided behind the cattle, for depofiting the dung at once, it will be by far the beft way, as much labour and expence in wheeling, &c. will be faved, and the dung will not be injured by it. Befides it will be prevented from being fcattered about the farm-yard, by which confiderable lofs is often fuftained.

The proper conftruction and paving of ftalls tend very materially to render the cleaning of cattle eafy and expeditious; though in fome places ftalls are fcarcely employed at all; the cattle either not being bound, or merely bound to ftakes without any divifions being made betwixt them, while in others they are confined feparately in narrow ftalls by rails, or the ftalls are made with only fhort divifions. Double-ftalls properly divided, and boarded fufficiently high to prevent the cattle from looking over them, are, in general, to be preferred; but ftalls of this kind are certainly more expenfive, and in many inftances unneceffary. In feeding-houfes each ftake fhould have a box or trough for meat, and in the middle a convenience for holding water, in order to ferve the beafts on each fide, which, in many inftances, may be filled by means of a pipe from a ciftern, or other place where water is kept. Thefe boxes or troughs may be made of either wood or ftone, and be joined together or feparate, as may be thought the moft convenient. Above thefe troughs a perpendicular rack fhould be placed for containing hay, ftraw, &c.

In paving the ftalls, the fame directions fhould be attended to as in that of ftables; for where cow-ftalls are paved with too great a declination, the animals always ftand in a very uneafy and uncomfortable manner, which is very prejudicial to their becoming fat, or feeding well.

Proper drains and refervoirs for the reception of urine, &c. are alfo of the greateft confequence, as without them it is utterly impoffible to preferve the animals that are kept in fuch houfes, fo fufficiently clean and fweet as is neceffary. Befides the moifture or juice, which is continually iffuing from dung and other fubftances in a ftate of diffolution, muft be received and detained in them, or the farmer will fuftain confiderable lofs in point of manure.

CALF-PENS.

In the conftruction of calf-pens there are a few things that ought be kept in

the mind of the builder. Though they ſhould not be ſituated in the cow-houſe, they ought not to be at an inconvenient diſtance from it. Great attention ſhould likewiſe be paid in laying the floors, as it is of much importance in rearing ſuch animals to keep them dry and warm. Calves, when intended for rearing, ſhould always be kept dry and airy, and rather cool, or at leaſt not over warm. By laying ſpars about two inches broad upon joiſts, at the diſtance of two inches from each other, ſo as to raiſe the floors two or three feet from the ground, according to ſituation, they will not only be kept perfectly dry, as the moiſture will be drained off, but freſh air will be admitted under the floor, by which means the noxious unpleaſant ſmells too frequently met with in calf-houſes, will be removed. It would alſo be a good practice to have ſtalls or diviſions in the calf-pens, ſo that each calf might be kept ſeparate, by which means they would be much ſooner fattened, and more ſecure from miſchief. Partitions, if about three feet high, and made of any thin light wood, might be ſo contrived as to be moveable at pleaſure, and capable of being increaſed or diminiſhed according to circumſtances. In theſe pens, ſmall round troughs may be placed for the reception of milk, where the calves are intended for rearing, and ſlight racks for a little hay in the higher parts of them. By theſe contrivances the food would be more equally, and more certainly adminiſtered to theſe animals *. Where great numbers of calves are rearing at the ſame time, contrivances might be adapted for ſupplying all the different veſſels at once, and with certain quantities of food, but this is not generally neceſſary.

DAIRIES.

The advantages of good dairy management are, in common, ſo great, that every farm ſhould have ſuitable accommodations for carrying it on in a degree proportioned to their kind and extent. Dairies are of three different kinds: the butter, the cheeſe, and the milk dairy. The laſt is principally in uſe near large towns, where the milk is carried as ſoon as poſſible to be ſold. A good butter-dairy ſhould have three apartments: a milk-houſe; a churning-houſe, in which there ſhould be a proper boiler, and other conveniences for ſcalding and waſhing the veſſels; and a place for keeping them in, as well as for drying them, when they cannot be put out of doors.

The cheeſe-dairy ſhould alſo conſiſt of the ſame number of rooms, namely, the milk-houſe, the ſcalding and preſſing houſe, and the ſalting-houſe. The cheeſe-room

* Beatſon in Communications to the Board of Agriculture, vol. I.

is commonly at a diſtance, but it might be very conveniently made over the dairy. For the milk-dairy, a good milk-houſe, and a convenient place for ſcalding, cleaning, and keeping the utenſils in, that they may be ſweet, are only neceſſary.

As a proper temperature of the air is of very great importance, the ſituation of the dairy ſhould be ſuch as that it may not be expoſed too much to the heat of the ſun in ſummer, or the coldneſs of the air in winter. The inconveniences attending the latter being, however, more eaſily removed than thoſe of the former, a northern expoſure ſhould be preferred, and one which is covered as much as poſſible by the ſhade of trees or houſes. If ſituated ſo that the ſun has no influence on any part of it, it is the better. Where no rooms are made above the dairy, the covering may be of thatch placed over tiles; but it is better to have rooms above, in which caſe the nature of the covering is not of ſo much conſequence. Thatch covering, in ſuch caſes, is however certainly the beſt, as being the warmeſt in winter, and cooleſt in ſummer; but tiles in theſe circumſtances are unneceſſary, and they prevent the thatch from being properly faſtened to the roof, and by that means to be liable to be blown off. The thatch ſhould be properly parged with lime-mortar on the inſide, to prevent any duſt falling upon the milk.

Stone walls are always to be preferred in ſuch buildings to brick, as being leſs permeable to the heat of ſummer, and the coldneſs of winter.

In regard to the proper height of the ceilings of dairies, different opinions are maintained. Eight feet, or eight feet and a half, would ſeem to be a ſufficient height for every purpoſe. But of whatever height the ceiling of the dairy be made, the windows ſhould always reach to the top, in order to prevent the ſtagnation of air near it, and be latticed, with ſlight frames adapted to them, on which gauze muſt be ſtretched, to permit a free circulation of air, and at the ſame time keep out flies, and other animals of the ſame kind.

Free-ſtone flags are the moſt ſuitable for floors. They ſhould be made quite ſmooth, and well jointed; but where theſe cannot be had, or are too expenſive, ſquare paving bricks, well laid and jointed, may anſwer tolerably well. Marble and other expenſive ſubſtances are ſometimes employed, but they come much too high to be uſed in common dairies; but of whatever materials the floor may be compoſed, it ſhould always be laid in ſuch a manner as to decline towards the middle, or ſome other more convenient part, for taking off the water with which it may be waſhed or flooded in hot ſeaſons. There ſhould be a well, with a pump, for this and other purpoſes, either in the dairy, or as near to it as poſſible.

If the dairy be ſmall, it will be ſufficient to have it fitted up with neat ſhelves, for the reception of the veſſels that contain the milk; but where it is on a large and

extenfive fcale, it may be fitted up with fuch cifterns or coolers as are fufficient to contain a meal's milk, when not allowed to be deeper than three inches. They may be lined with lead, or made of marble or flate, where it is to be had; excellent ones are made by Mr. Hind, at the Slate Pits, at Swithland, near Leicefter, of the laft fort of material; but from the former there will be little danger, if they be kept fufficiently clean*. Thefe coolers fhould be furnifhed with a plug at the bottom, and a cock to let out the milk, or the water when they are wafhed. At the backs of them, too, there fhould be cocks for the purpofe of letting in water to clean them with. A large cock ought likewife to be placed in fome convenient part of the dairy for letting water upon the floor when it is neceffary to clean it, and cool it in hot feafons.

With a view to afford a neceffary degree of heat in the winter feafon, flues may be made to proceed from the fires either in the churning-room, or the place where the utenfils are dried and kept in proper condition. Thefe flues ought to be conftructed in fuch a manner that the heat may be regulated as occafion requires, or wholly ftopped if neceffary.

Both the walls and the ceiling fhould be fo plaftered that there may be no cracks or crevices for the lodging of duft or infects. Sometimes a part or the whole of the wall above the coolers is fet with fmall glazed Dutch tiles, which gives the dairy a neat and clean appearance.

The room for churning in fhould be as near as poffible to the milk-houfe, and be provided with a fire-place and furnace, and alfo a proper boiler for heating water to fcald the different veffels, as well as other purpofes. It is an additional convenience if a pump can be had, with fuitable contrivances to it for filling and emptying the boiler.

The place in which the utenfils are kept fhould likewife have a fmall fire-place in it, in order that they may be well dried, in cafe they cannot be put out into the open air, which is always the beft method, ftone fhelves being placed on the outfide for fuch purpofes. But ftrips of wood placed in this direction ≡≡≡ inftead of ftone fhelves would probably be much lefs expenfive, and the veffels be found to dry much better upon them. The cream may be put into this room when the weather is cold, or juft before it is churned, which is frequently found to be a good practice. In all the chimneys the greateft care muft be taken to prevent their fmoking, as when that is the cafe, it is highly prejudicial to the milk and cream, as well as the utenfils of the dairy.

For the cheefe-dairy, the milk-houfe fhould be nearly on the fame conftruction with

* Very good coolers might probably be made from the beautiful black flate lately found on the eftate of Lord Penrhyn, in Wales, as it may be raifed to any thicknefs, and is capable of receiving a polifh nearly equal to marble.

that which has been juſt deſcribed; all the milk being ſeldom made into cheeſe, there may be a neceſſity for coolers. Where the contrary is the caſe, it may be more convenient to have ſhelves for the milk veſſels, by which means they will always be at hand for carrying milk to the cheeſe-tubs, or copper when it is to be made warm.

The preſſing or ſcalding room may be made on the ſame plan as the churning-room deſcribed above; only it muſt be provided with a good cheeſe-preſs, which is much more handy than having it at a diſtance, as is often the caſe.

It would, perhaps, be ſtill more convenient to have one room large enough to ſerve for the ſeveral purpoſes of preſſing, ſcalding, and ſalting houſe. The ſalting-room ſhould be laid with flags, and made ſo as to readily carry off the water when it is waſhed out. It ſhould alſo be provided with a ſtrong table or ſhelf, for laying and turning the cheeſe upon, until they are in a proper condition for being put into the cheeſe-room. A convenient place ſhould likewiſe be made near to, or in, the houſe for containing ſmall ſand, for the purpoſe of ſcouring the dairy ſhelves and utenſils.

The cheeſe-room may be made over the dairy, but it is moſt commonly made above the cow-houſe or kitchen, the warmth of ſuch places being ſuppoſed to promote the ripening of the cheeſes *.

FARM-SHEDS.

These buildings are often extremely convenient and proper for various purpoſes of the farm. They are cheap and ſimple in their conſtruction, and erected without much labour. Places of this kind are moſt commonly made ſo as to lean to and reſt againſt the walls, or other parts of buildings, the eaſing or lower part being ſupported by a ſlight wall, poſts of wood, or ſtone pillars. Frequently, too, the whole of their roofs is ſuſtained by poſts or pillars. Theſe ſheds are of much utility for preſerving all the larger ſorts of farming implements from the effects of the weather, as well as for the protection of young animals of different kinds, ſuch as horſes, cattle, ſheep, &c. when they are turned looſe in the farm-yard. They might alſo be ſo contrived as to admit of ſtowing large quantities of different kinds of hay, when brought from the ſtack for the uſe of the cattle; by which it would be extremely ready and near at hand for foddering with; but not for depoſiting it in when firſt brought from the field, as in ſuch caſe it would be much leſs valuable. They may alſo be applied to various other uſes, which abundantly ſhews their importance in the economy of farm-buildings.

* Beatſon in Communications to the Board of Agriculture, vol. I.

STRAW-HOUSES.

Where the practice of ſtacking ſtraw prevails, theſe houſes are not ſo eſſentially neceſſary; it is, however, always adviſable to have ſome place or other in which a ſmall quantity can be depoſited for the daily ſupply of different animals, as by this means much time, as well as ſtraw, will be ſaved, and there will be much leſs dirt and litter about the yard.

ROOT-HOUSES.

Where a number of cows or cattle of any kind are fed on winter roots and vegetables, ſuch as carrots, turnips, potatoes, cabbages, &c. it is highly neceſſary to have houſes of this ſort, in which they may be placed and kept near at hand, when the ſeaſon is bad, for the daily ſupply of the cattle. But ſome vegetables, ſuch as cabbages, will not bear to be laid up in houſes in any conſiderable quantities, or for any conſiderable length of time, as they are apt to run quickly into the ſtate of fermentation, and become putrid.

POULTRY-HOUSES.

In every caſe where any conſiderable number of poultry are kept, a place ſhould be provided for confining them in. This is particularly neceſſary for the farmer, as he may otherwiſe not only ſuſtain conſiderable injury by their depredations, but loſe much of the profit ariſing from them, by their being frequently killed, and their eggs loſt in the hedges and other places. As a free and uninterrupted circulation of air is highly neceſſary to the preſervation of the health and feeding of poultry, they ſhould not be cooped up in dark reſtricted hovels, but have a large ſuitable place conſtructed entirely for their uſe. It is not, perhaps, yet well aſcertained, whether different ſorts of poultry do better when kept ſeparate and diſtinct or not, though it would ſeem to be the caſe, as the economy and habits of each are different. Where ſufficient room can, therefore, be ſpared, it will be the propereſt method to have the entrances, as well as the reſting and breeding places of each ſort, diſtinct from the reſt; though the whole may be contrived ſo as to be under the ſame roof, and conſequently be fed from the ſame place, which will ſave time and trouble. If room can be had, there ſhould likewiſe be a yard proportioned to the number provided for the

whole ſtock, which ſhould be fenced in, in ſuch a way as to prevent their flying over, or getting through, and which ſhould communicate with the poultry-houſe, and be well ſupplied with water. If a pond or ſtream of water can be had, it is ſo much the better.

By theſe contrivances it will be found that poultry of all kinds may not only be bred and reared with great facility, but be kept more free from diſeaſe and accidents.

HOG-STIES.

In the conſtruction of theſe, little more is required than that they be made ſufficiently dry and warm, and that ſmall yards or areas be provided for the holding of troughs, and the reception of the food. It is probably the beſt and cheapeſt method to make them with ſhed-roofs, and neither very high nor wide; ſix or ſeven feet wide is quite ſufficient for a diviſion. There ought to be many of theſe diviſions, in order to ſuit different purpoſes, and contain different ſorts of hogs. Some ſhould be made for ſows when with the boar, others for brood hogs, and for farrowing, weaning the young pigs, and fattening in, &c.

As hogs are apt to ſlop over and ſpill a part of their food, by getting their feet into the troughs, there ſhould be a thin piece of board nailed on the back part of the troughs, ſo as to come forward, in a way to only juſt admit their heads; and they ſhould have a ſufficient number of diviſions, each riſing a little above the top of the trough. Many other ſorts of troughs may likewiſe be eaſily contrived for preventing the waſte of food, and it may be done by placing them in the diviſions of the yards.

It would be of great advantage to have conveyances for water, ſuch as open ſpouts for inſtance, paſſing through the ſties, in order that they may be frequently waſhed and kept clean, and that the hogs may drink when neceſſary.

In the conſtruction of theſe buildings, care ſhould likewiſe be taken that the animals be fed conveniently, and without going among them. Where a few ſwine are merely kept for family uſe, they may, if ſituation will admit, be fed with great eaſe and facility, by having holes, and troughs placed in the walls of the back kitchen of the farm-houſe. By this contrivance much ſtuff, which would otherwiſe probably be loſt, may be conveyed to them. Where a great number of hogs are conſtantly kept, it may be advantageous to have a furnace and copper near to the ſties for preparing their food.

COAL AND WOOD HOUSES.

FIRING being every-where an article of conſiderable expence, it is neceſſary that a proper and convenient place ſhould be provided for it. Houſes or yards for this purpoſe have moſt commonly been made without roofs or other coverings, but as coals are much injured by expoſure to the ſun and weather, they ought always to be well covered. They are more durable, however, when made wet before they are uſed. Where large quantities are conſumed, the large and ſmall coal ſhould be put ſeparately; and places made for putting cinders, and ſuch wood as has been broken up: if peat or wood only be uſed, theſe houſes ſhould be much larger and better ſecured in the roofs. Theſe places ſhould always be ſituated as conveniently as poſſible for the kitchen.

WORK-SHOPS.

WHERE the farm is extenſive, a place of this ſort is extremely uſeful and convenient, for making and repairing different kinds of tools, as well as for preſerving materials ready ſeaſoned and prepared for the purpoſe of conſtructing or mending ploughs, harrows, carts, wheels, and other implements of huſband y. By this means the farmer is ſure of having his timber in proper condition, and always ready to his hand. Theſe ſhops ſhould always be provided with a good ſet of carpenter's tools, a bench to work upon, a lathe for turning different things, and a convenient grind-ſtone; and a blackſmith's ſhop may often be neceſſary on farms of very conſiderable extent.

It would likewiſe be of advantage to have a place for timber, and a ſaw-pit near at hand. The latter might be made under the ſame roof with the work-ſhop, if convenient. In the former all ſorts of wood or timber, and the broken or worn out implements ſhould be depoſited.

TOOL-HOUSES.

THE ſmaller ſorts of tools, ſuch as ſpades, forks, rakes, ſcythes, &c. &c. being exceedingly liable to be loſt, a place ſhould be provided for laying them in when not in uſe. Sacks, ropes, twine, nails, and old iron, may alſo be laid up with them. For this purpoſe the place need not be large, but it ſhould be dry and free from damps. Of this room, the maſter of the farm ſhould always keep the key, in order that he may readily know where to find ſuch tools, or other articles, as he may want.

STORE-ROOMS.

The farmer, in particular ſituations, frequently finds it neceſſary to ſtore up ſome of the produce of his grain; ſuch, for inſtance, as meal, in order to get a better price for it; he ſhould, therefore, be provided with a ſuitable ſtore or meal room. Theſe rooms ſhould be as dry as poſſible, and perfectly ſecure from vermin. An upper floor is probably the beſt for ſuch purpoſes, provided the articles can be conveniently and eaſily conveyed to it. They ought to be furniſhed with ſtrong well-made cheſts, for holding the meal, or other articles, that may be put into them. If meal, it ſhould be well rammed or preſſed down, by means of a proper beetle, in order to make it keep ſweet and well.

FARM SERVANTS'-ROOMS.

Where farms are extenſive, and, of courſe, many ſervants required, eſpecially if they be unmarried, proper and convenient accommodations for ſleeping, and, where they find their own proviſions, for preparing and dreſſing them in, are not only neceſſary, but highly advantageous both to the farmers and the men; they ſave much time, which would otherwiſe be loſt, in going to their meals, and keep them together ſober, ſteady, and ready for their buſineſs. Beſides, the men in this way are much more comfortable, and live conſiderably cheaper, than when it is the cuſtom to go to public-houſes, or other ſuch places, for their meals, which is too much the caſe in many of the more ſouthern diſtricts of the kingdom, by which their manners often become depraved, and their conſtitutions enfeebled, by the great uſe of ſpirits, and other intoxicating liquors.

Theſe inconveniences are, however, the moſt effectually provided againſt by ſuch ſervants being provided for, where it can be done, from the tables of their maſters. Where this laſt method is followed, the eating-rooms ſhould be ſo ſituated that they may be overlooked with facility; but the lodging-rooms in both caſes are the ſafeſt, perhaps, when made in a building quite detached and diſtinct from the other houſes and offices, perſons of this deſcription being often extremely negligent of their fires, candles, &c.

Whatever ſituation may be fixed upon for theſe conveniences, the ground floors ſhould always be of ſtone or brick, and the upper ones made with plaſter, as in ſome of the midland counties; or brick, which is eaſily and frequently laid. In con-

ſtructing theſe floors, the joiſts are laid in the common method, then a ſtrong ſort of reed is faſtened down to them, upon which the plaſter is placed. If with brick, the joiſts are laid twelve inches apart, and the bricks made to reach from joiſt to joiſt, and joined ſides and ends with well-wrought mortar; it might alſo be adviſable to have the ſtairs made of the ſame materials. In order to ſave this laſt material, there is, however, ſometimes a ſlight coat of common lime laid on firſt, ſo as juſt to fill up the inequalities; the plaſter being afterwards ſpread about two inches thick upon this, in doing which great expedition muſt be uſed. Where reeds cannot be procured, ſmall thin laths may be employed in their ſtead; theſe are, however, more expenſive. In the diſtricts where this mode of conſtructing floors is practiſed, the plaſter is prepared and ſold at the kilns for about ſix pence the buſhel; and the expence of putting it on, if burnt and prepared, is about five pence the ſquare yard.

The places for the ſleeping of ſervants may be ſo contrived as that ſeveral perſons may be accommodated in a narrow compaſs; this is done by the beds being fixed and placed in double tires one above another, four beds in this way only occupying the room of two on the uſual plan. The approach to the upper beds may be rendered ſufficiently eaſy and convenient, by having proper ſteps or ſtairs; and may be made either on the ſame ſide with the other beds, or on the contrary, as from ſituation, and other circumſtances, is the moſt ſuitable. It will however be proper, and even highly neceſſary, where ſo many perſons ſleep in ſo ſmall a compaſs, that the windows be pretty large, and ſo contrived as to readily admit of a free circulation of pure air*.

Beſides the buildings and accommodations, which have been already deſcribed, there are ſeveral others that are frequently neceſſary both for the convenience of the houſe, and the feeding and management of different kinds of ſtock.

Thoſe of the firſt kind are chiefly places for brewing, baking, waſhing, ſlaughtering animals in, &c. and for keeping pigeons, bees, and other ſtock of a ſimilar nature. The ſituation and conſtruction of many of theſe are, however, not only ſo ſimple and well underſtood, but muſt ſo frequently depend on particular circumſtances, that it is unneceſſary to give detailed accounts of them.

* Though this method may ſave much expence, as well as room, it will certainly be diſadvantageous in point of health; for it muſt be obvious to every one the leaſt converſant with the nature of airs and reſpiration, that the air of ſuch ſmall cloſe rooms muſt quickly be diſoxygenated and rendered noxious by the breathing, perſpiration, and heat, of ſo many perſons, and that unleſs ſeaſonable ſupplies of freſh air be admitted, dangerous conſequences may enſue.

Fig. 1 Double Barn.

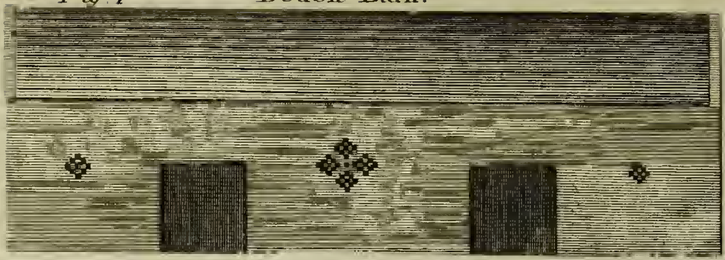
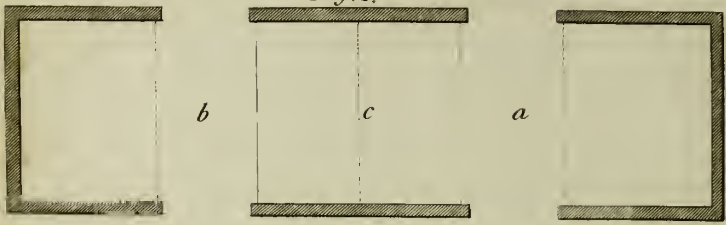
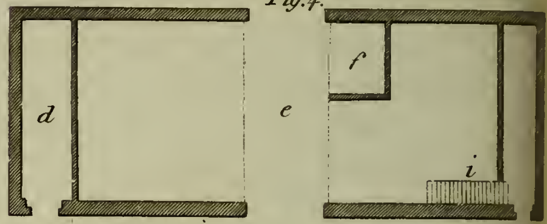


Fig. 2.



Improved Barn. *Fig. 3.*

Fig. 4.



Open Barn. *Fig. 5.*

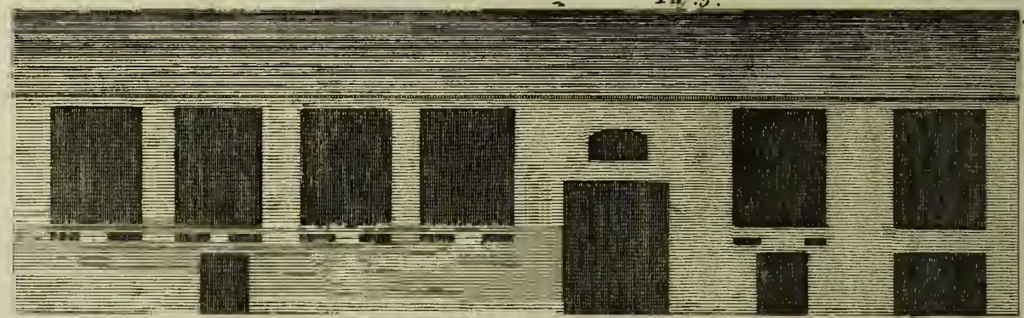


Fig. 6.

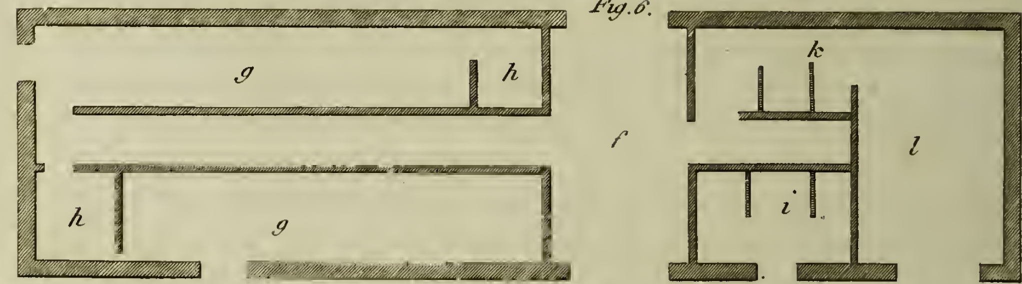


Fig. 7. Barn with Granary & Threshing Machine.

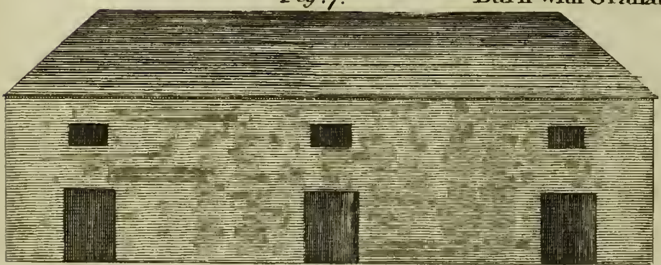


Fig. 8.

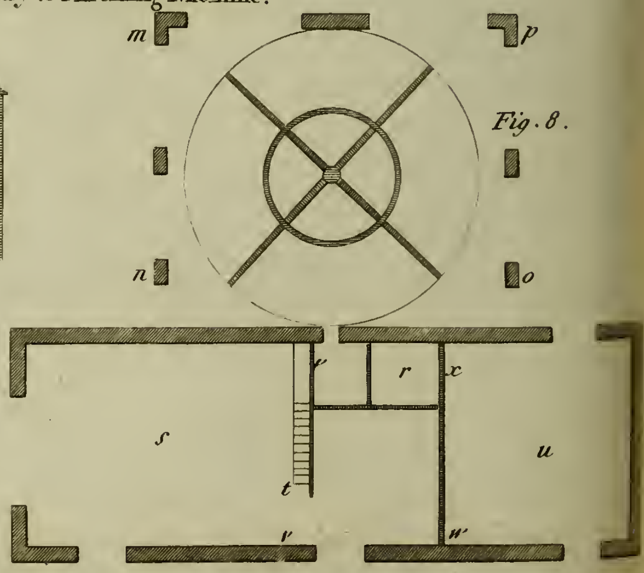


Fig. 9.

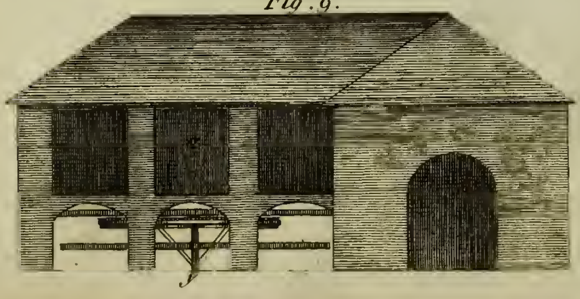


PLATE XVIII.

Barns.

[*To face Page* 64.]

At *Fig.* 1. is reprefented the plan and elevation of a *Double Barn*. *Fig.* 2. The ground plan, *a* and *b* the thrafhing-floors; *c* a dotted line, fometimes built fo as to form a partition.

Fig. 3. Is the plan and elevation of an *Improved Barn*. *Fig.* 4. The ground plan: *e* the thrafhing-floor; *f* bin or room for thrafhed grain; *i* ftairs leading to granary, with place under for roots, &c.; *d* place for tools or other purpofes.

Fig. 5. Shows the plan and elevation of a large *Open Barn*. *Fig.* 6. The ground plan: *f* the thrafhing-floor placed towards one end; *g g* cow-houfes containing eleven ftalls on each fide; *h h* calf pens with fparred floors; *i* a double ftall, with two fingle ones for four cows; *k* two ftalls; *l* a work-fhop, root-houfe, or place for keeping implements. The corn in the ftraw is kept above. The large openings in this barn fave much expenfe in building.

Fig. 7. Front and end elevation, with plan of a barn, and thrafhing-machine for a three-horfe power. It is contrived to winnow and clean the grain while thrafhing, and may be made to cut chaff, fplit beans, hoift the produce up to the granary, and execute various other forts of work, as grinding, pumping, &c. *m n o p*, *Fig.* 8. is the fquare for the horse-path, the dotted circle the path. *y*, *Fig.* 9. is the upright fhaft in its centre; and *z* a granary or ftore-room for ftraw, hay, &c. over it.

At *v*, *fig* 8. may be made a communication to afford eafy accefs to the mill when corn is lodged there for thrafhing. The mill-head is erected on a floor about feven or eight feet above the ground floor, to give room for the fanners or winnowing machine below. It is extended the whole breadth of the barn, and about 15 feet or more towards *s* from the back part of the mill at *q* by which, and being properly partitioned below, a very neceffary and ufeful divifion, *z*, may be got for containing the clean corn till drawn up to the granary: the door of this place may be kept locked for fafety.] The fpace *r* contains the chaff blown from the fanners a door by through the partition to render the communication more eafy and expeditious from the part *s* where the unthrafhed corn is laid: a door might alfo be made in the partition at *w*, but this is not fo neceffary, as may be feen where the ftraw goes, by ftanding on the thrafhing-mill floor, to which there fhould be fteps up at *t*. It may be made alfo to rake away the ftraw, and to throw it down to the part *t*, which will fave a perfon raking from the mill. The expenfe if, made to clean the corn and rake away the ftraw only, which in general is fufficient, will be about 50*l*. exclufive of flooring, &c. If made to hoift up the corn, to fplit peas or beans, and cut ftraw, from fix to ten pounds more for each of thefe operations.

Thefe plans are recommended by Mr. Beatfon, as very ufeful where barns and thrafhing-machines are neceffary.

STACKING APPARATUS & GRANARY.

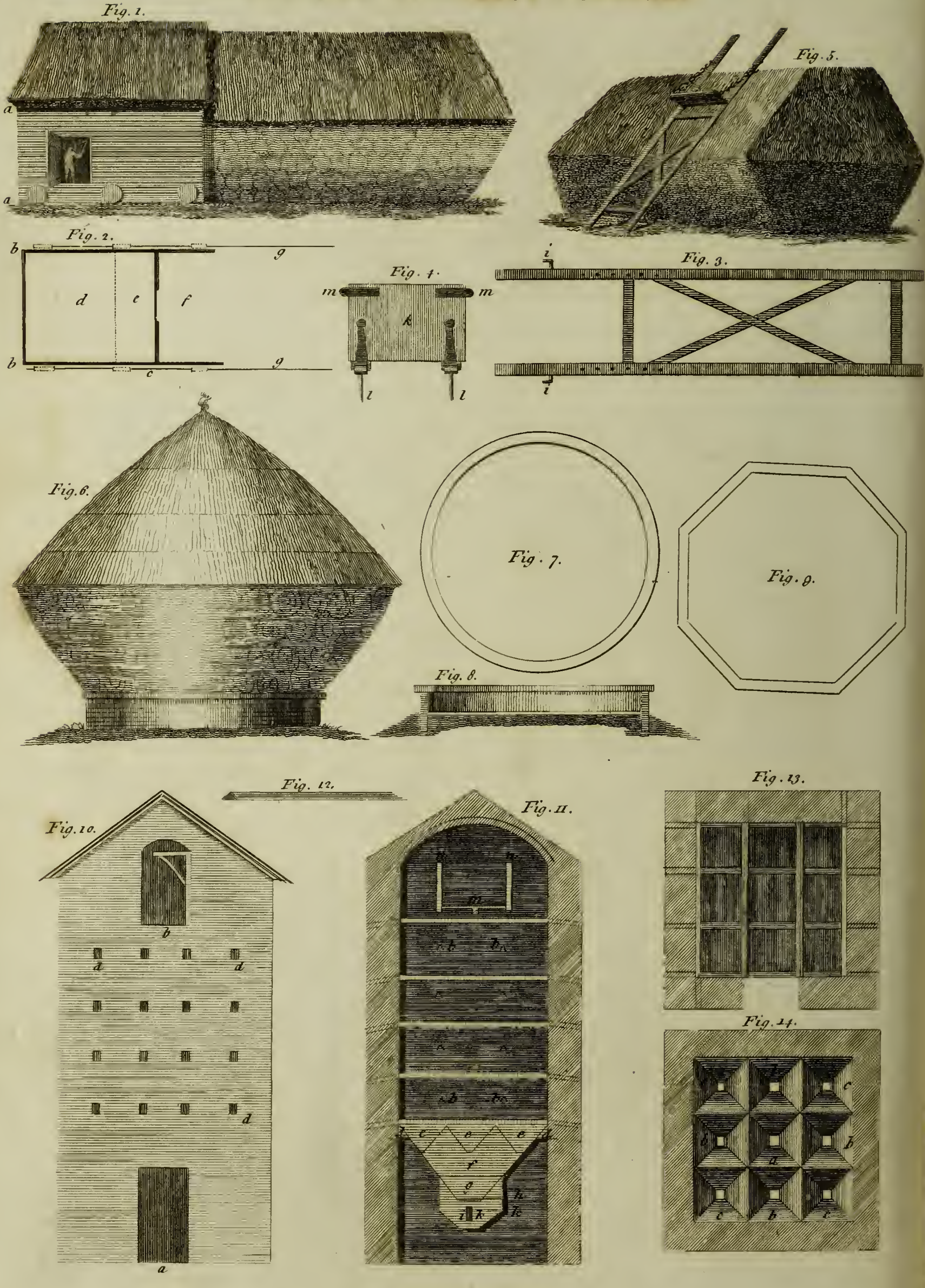


PLATE XIX.

Stacking Apparatus and Granary.

[*To face Page* 64.]

Fig. 1. Reprefents a moveable fhed, which, after the work of the day, is drawn forward over the unthatched ftack.

Fig. 2. Is a plan of the fame contrivance.

Fig. 3. The frame of a moveable ftage. *i. i,* iron hooks.

Fig. 4. The ftage, to be fixed, by means of the pins *l. l,* into the holes of the frame. Chains are faftened on the plates *m. m,* and from thence put over the hooks *i. i.*

Fig. 5. A ftack with the moveable ftage erected againft it.

Fig. 6. Is an elevation of a ftack on its ftand.

Fig. 7. The plan of a round ftand for corn ftacks.

Fig. 8. A fection of the fame ftand.

Fig. 9. Is a plan of a ftand for an octagon ftack.

Fig. 10. Is the elevation of an improved granary. *a* the door; *b* the crane for lifting the corn into the upper loft; *d d d* air-holes, to ventilate the different lofts.

Fig. 11. Is a fection of the fame.

Fig. 12. Shows the plan of the floor, in which the middle is higher than the fides.

Fig. 13. Reprefents the method of conftructing the tops of the bins, in which the corn is put.

Fig. 14. The bottoms of the bins, formed in the fame manner as the hoppers of a common mill.

HORSE STALLS & SINGLE CATTLE SHEDS.

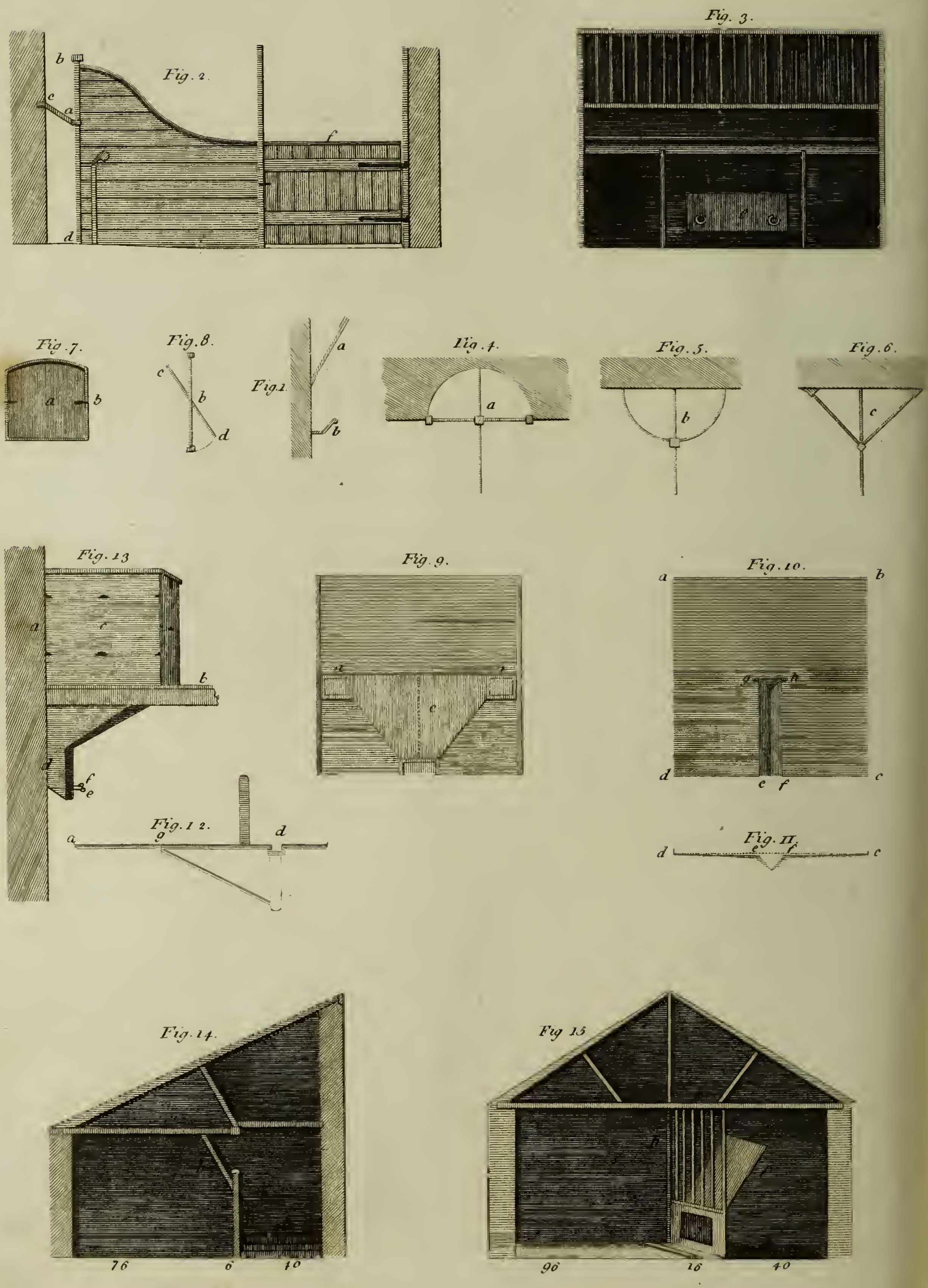


PLATE XX.

Horſe Stalls and Single Cattle Sheds.

[*To face Page* 64.]

Fig. 1. Repreſents the common method of placing the racks and mangers in ſtables: *a* the poſitions of the rack; *b* that of the manger.

Fig. 2. Shows the improved poſition of racks 14 inches from wall; *a b* ſpars of rack; *a c* bottom of rack, ſparred for ſeeds to fall down to *d*, whence taken out by drawer *e* in fig. 3; *f* a door ſometimes made uſe of in ſtables.

Fig. 3. Is a front view of rack and ſeed box.

Fig. 4. Repreſents racks placed in niches in the wall ſo as to ſerve two ſtalls; *a* diviſion betwixt.

Fig. 5. Shows the ſame placed in the angles without niches; *b* diviſion betwixt.

Fig. 6. Exhibits the form of racks for the angles; *c* the diviſion.

Fig. 7. and 8. Show the manner of fixing the windows or ſhutters: *a* the front view of window with ſhutter fitted to it, being ſuſpended on iron pins in the middle at *b b*, on which it turns; *b*, fig. 8. is a ſide view, ſhowing poſition of ſhutter, *c d*, when opened a little.

Fig. 9. Repreſents a ſort of hopper or contrivance, where neither racks nor mangers are employed; it is 14 inches wide at bottom, and ſparred for the ſeed to drop into a drawer; *a a* boxes in the corners for corn; *b b* hay-manger divided by the dotted line *c*.

Fig. 10. Is a ſtall: *a b c d* the ground-plan; *a b* inner end to which the horſe is tied. It is paved on a level from *a* to *d* and from *b* to *c*, a ſmall ſeven-inch drain being left in the middle, as *e f h g*, made to within 3 feet of inner end, forming an angle at bottom, as ſhown in croſs ſection, fig. 11; depth at *g h* 3 inches, ſloping to *d* in longitudinal ſection, fig. 12. into which the ſtall-drains paſs; theſe being covered by two-inch plank perforated with holes ſecured by hinges or two iron pins, *g h*, fig. 10. The main drain may be made at *d* in the end of the ſtall, or otherwiſe as convenient.

At fig. 13. is ſhown a corn-bin: *a* the wall of ſtable; *b* the floor of room; *c* corn-bin with air-ſpouts; *d* a ſpout below the bin in ſtable; *e* a plate iron ſlider at its bottom with lock if neceſſary; *f* another ſlider to regulate the feed between it and *e*, the feeds being this way eaſily taken out.

Fig. 14. Repreſents a *ſingle cattle ſhed*: *a* the paſſage before cattle; *b* rack for hay or ſtraw; *c* a room for fodder, litter, &c.

Fig. 15. Shows another method of conſtruction in theſe ſheds uſed in Shropſhire: *d* the paſſage; *e* perpendicular rack, with thin deals behind in poſition, *f* for hay: under *f* is a ſquare hole *g*, oppoſite each ſtall, for foddering the cattle through from paſſage *d*. Theſe were deſigned by Mr. Beatſon, and are cheap and convenient.

Double Cattle Sheds.

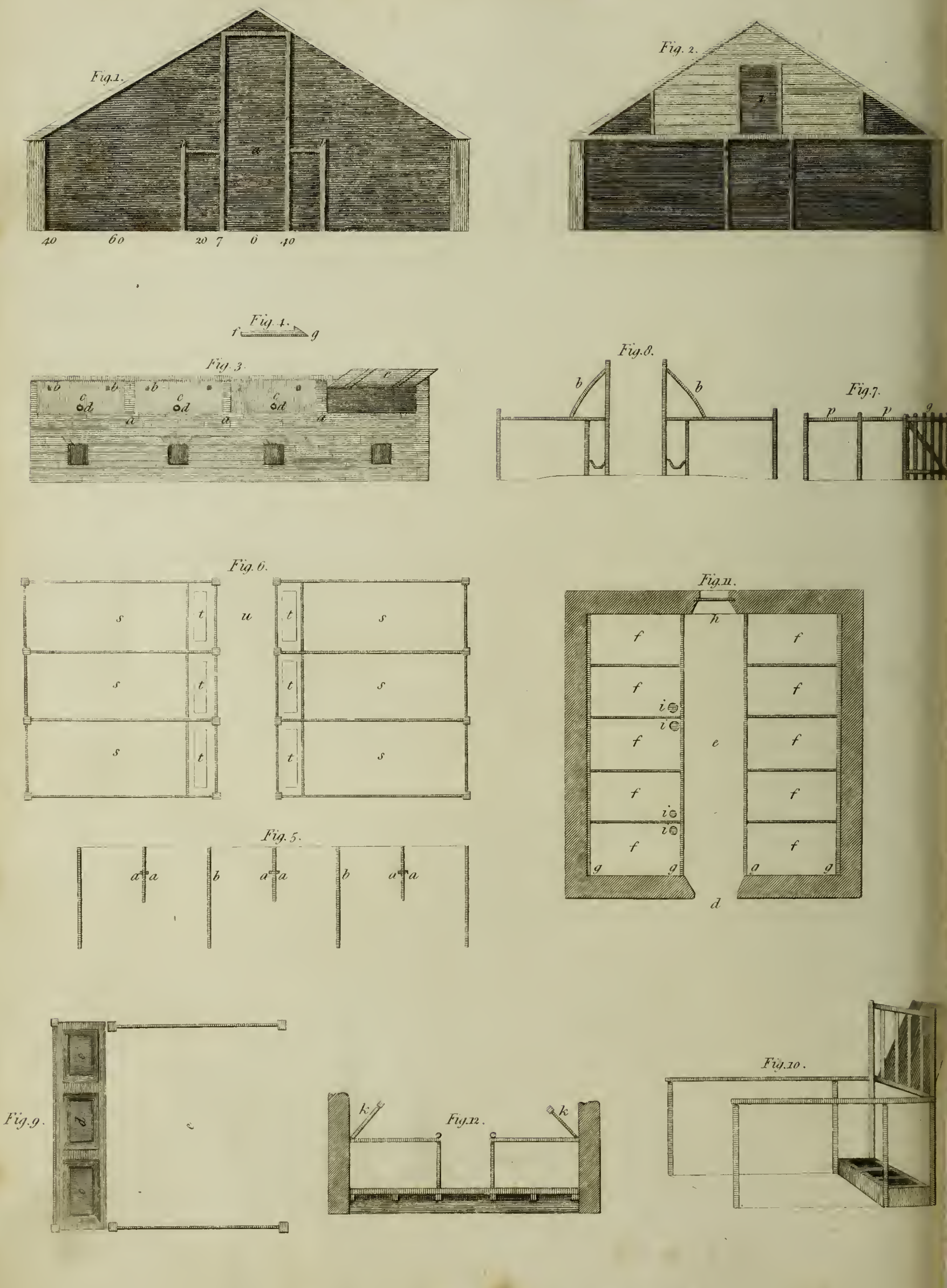


PLATE XXI.

Double Cattle Sheds.

[*To face Page* 64.]

Fig. 1. Reprefents a *double fhed* for cattle, in which *a* is the paffage before the heads; *b b* ftakes to which they are tied up; *c c* pofts or pillars for the purpofe of fupporting the roof. It may be an advantage to have racks when neceffary, as in fig. 15, Pl. XX.

Fig. 2. Reprefents another form of double fhed, in which *a* is the gangway before the cattle; *b* a room over which may ferve many different purpofes.

Fig. 3. An internal part of the fheds for containing the fodder. In fingle fheds it is contrived fo as to admit its being put in from the cart by having covers that open on hinges: the roof being fupported on pillars *a a a*, three or four feet in height, placed on the wall at the diftance of eight or ten feet from each other: *b b b* the hinges; *c c c* the covers; *d d d* rings for pulling them open by; *e* one of the covers open, and held by the catch *f g*, fig. 4. which is moveable on a fmall pin, the heavy end, *f*, within the fixed boards, and the other, *g*, without, to catch in a hole made for the ufe in the cover when opened.

Fig. 5. Reprefents plans of ftalls with flight divifions betwixt them, where cattle are bound in pairs, as in many of the northern diftricts: *a a a* the ftakes to which they are tied; *b b b* the partitions of the ftandings.

Fig. 6. Plans of narrow ftalls, where the cattle are not bound, but confined feparately in them. *s s s* the ftalls; *u* the paffage betwixt; *t t t* the troughs from which the cattle feed.

Fig. 7. The elevation of the hind part of thefe ftalls: *p p* rails to lift out at the ends; *g* a little hatch or gate fometimes made ufe of.

Fig. 8. Is a fection of thefe ftalls: *b b* fhort rails or braces to keep the cattle from touching with their horns.

Fig. 9. A plan of a ftall: *c c* troughs for meat; *d* a ciftern for water between them, ferved by a pipe from a pond, &c.; *e* a rail-divifion or partition betwixt, when neceffary for confining them more fully.

Fig. 10. Is a fection or view of one of thefe ftalls with the rack placed over it.

Fig. 11. The plan of a double *calf-pen*: *d* the door; *e* the paffage between the pens; *f f f* the pens in which the fituation of the partitions is feen; *g g g g* four joints in which are holes for pins to keep the partitions in their places; *h* a door or window at the end, and other air-holes may be neceffary; *i i i i* troughs for milk.

Fig. 12. Is a fection of thefe pens; *k k* the pofition of the racks.

DAIRY HOUSE & IMPLEMENTS.

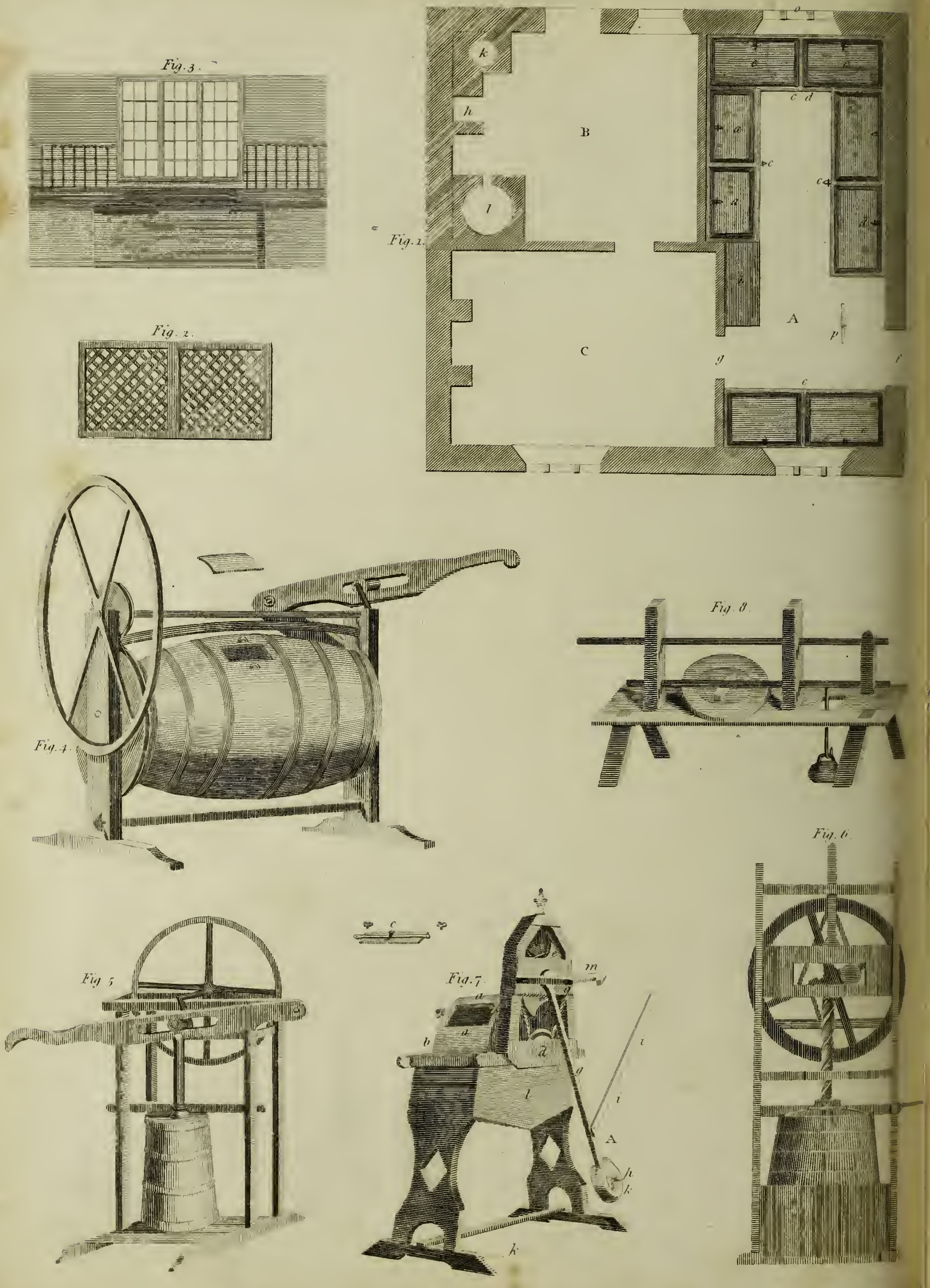


PLATE XXII.

Dairy-Houſe and Implements.

[*To face Page* 64.]

Fig. 1. Repreſents an improved form of Dairy, uſed by Mr. Wakefield, near Liverpool: in which A is the milk-houſe; *a a a* the coolers; *b* a ſlab for laying butter upon after it has been made up; *c c c* cocks for drawing off the milk from the coolers, one ſerving two coolers by the contrivance of a ſhort piece of leaden pipe from the holes, *o o o*, which are ſtopped by the plug *p*, being made ſufficiently long to extend above the ſurface of the milk; *d* a large cock to throw water upon the floor, which is laid with a little ſlope from that part; *e e e* cocks at the back part of the coolers for letting in water; *f* a door latticed, as ſhown at *Fig.* 2; *g* another pannelled door. B the churning-room; *h* a fire-place; *k* a boiler; *l* large boiler or copper for ſcalding implements or other uſes. C. a room for airing or drying utenſils, and may be uſed as a laundry. Over theſe may be made ſervants' lodging-rooms if neceſſary.

Fig. 3. A view of the inſide of the dairy at the end Q.

Fig. 4. The improved barrel-churn with wheel.

Fig. 5. An improved upright churn, put in motion by a crank and lever, which is very convenient and uſeful where large quantities of butter are not made.

Fig. 6. Rowntree's improved butter-churn.

Fig. 7. Bowler's *pendulum churn:* A A is the body of it; B an opening by which the cream is introduced; C the cover of the large opening, the ſmall hole on the oppoſite ſide not being ſhown; D the gudgeon on which the body hangs; E the upper larger pulley; F the ſmaller pulley fixed on the axis or gudgeon; G G the rod of the pendulum ſuſpended from upper pulley E; H bob of pendulum; I I the handle, moveable on a pin at *a*, ſwinging in the form of dotted line K K; L the trough for hot or cold water; M a projecting piece of wood for ſupporting the handle, I, when the churn is not at work.

Fig. 8. Is a cheeſe-preſs on the principle of the lever. Screw-preſſes are, however, common in moſt dairies, as being more convenient and more eaſily managed. In theſe caſes the ſtone, or weight, is fixed in a frame of wood; in the upper part of which the ſcrew acts ſo as to readily wind it up or let it down as may be neceſſary.

Steam Boiler for Potatoes

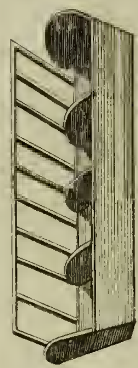
Fig 11

Dublin Potatoe Set Scoop.

Fig 10

Mr. Starks Potatoe Set Scoop.

Fig. 5.



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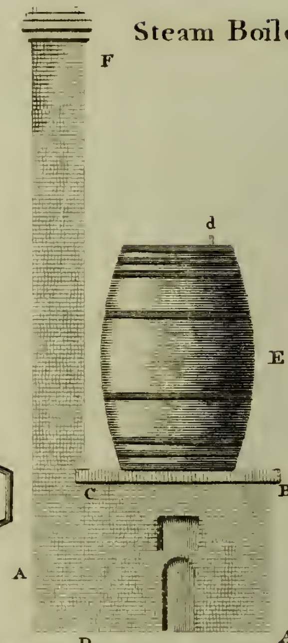


Fig. 6.

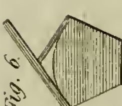
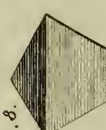


Fig. 9.

Fig. 8.



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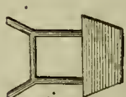


Fig. 2.

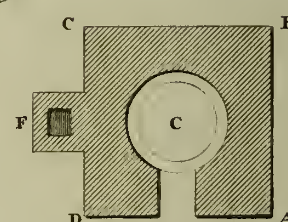
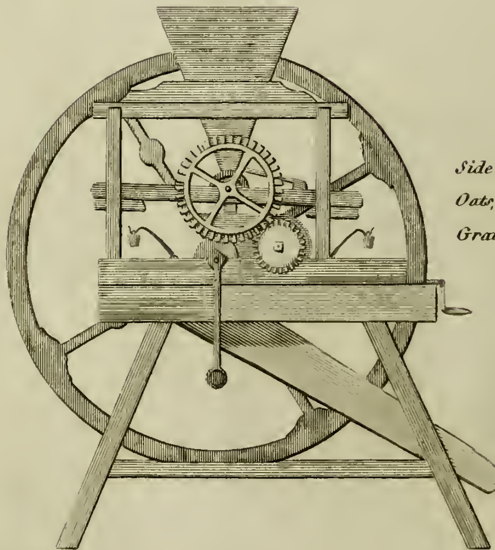
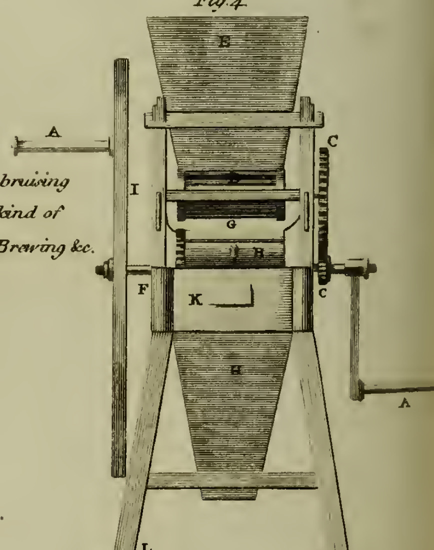


Fig. 3.



Side & End View of a Machine for bruising Oats, Beans, Peas, Barley or other kind of Grain for feeding Cattle, Malt for Brewing &c.

Fig. 4.



Printed for Richard Phillips, 71, St. Paul's Church Yard.

PLATE XXIII.

Steam Boiler and Bruiſing Machine.

[*To face Page* 64.]

Fig. 1. Is the repreſentation of a *Steam Boiler* for potatoes or other roots, in which the parts A B C D in it and in *fig.* 2. are formed of brick or ſtone, being conſtructed in a cubical form, about three feet in every direction. *a* the door of furnace; *b* the aſh-pit; *c* a ſhallow iron kettle twenty inches in diameter, and ſeven or eight inches in depth, placed over the furnace. B C a flat ſmooth ſtone covering the whole of the work, in the middle of which is a round hole cut out, to admit the iron kettle in a cloſe manner. E a caſk, the bottom of which is perforated with auger-holes and placed over the ſteam kettle, when filled about half full with water. The caſk is then filled with potatoes, and cloſely clayed all round, to prevent the eſcape of ſteam, and the cover put on cloſe. *d* a ſhort thick plug, put ſlightly in a hole in cover, to afford air, or rendered moveable by a leathern hinge. F flue or vent, which may be built to a houſe or any other place. When the potatoes are ſufficiently ſteamed, the roots are commonly removed by a wooden ſhovel, or by turning the caſk over. But it might be ſo contrived as to move on pivots in the middle of the boiler, in a frame, ſo as to be readily turned upſide down when neceſſary to empty it. It is made uſe of by Mr. Wakefield, near Liverpool.

Fig 3. Is a ſide view of Mr. Rowntree's machine for bruiſing different ſorts of grain, as well as peaſe, beans, &c. for the purpoſe of feeding horſe- or other ſorts of teams. It is likewiſe capable of application in the grinding of malt for brewing.

Fig. 4. Is an end view of the ſame machine. This machine is conſtructed with two iron rollers of different diameters, turned true on their axles or ſpindles, each roller having a cog or tooth wheel. A roller with grooves is fixed under the hopper, to receive the grain from the hopper and lay it on the two rollers. To one of the rollers is fixed a fly wheel. The machine is made to be worked by hand or any other power. The upper wood frame is made to ſlide, and is regulated by a ſcrew according to the ſize of the grain, and will bruiſe it more or leſs as may be required.

AA the handles.
BB the rollers for bruiſing the grain.
CC the cog or tooth wheels for turning the rollers.
D the fluted roller which receives the grain from the hopper E.
F the ſliding frame.
G the ſcrew for regulating the rollers.
H the ſhoot or trough for conveying away the grain from the rollers.
I the fly wheel for regulating the motion.
K two ſcrapers hanging on centres for keeping the rollers clean.
L the frame.

Fig. 5. Exhibits a form of hog-trough contrived ſo as to prevent waſte by ſpilling, from the hogs getting their feet in, by having a piece of deal nailed on the back of it.

Figs. 6. 7. and 8. Show the method of making the divifion in hog-troughs, which need not go to the bottoms.

Fig. 9. Reprefents another method of preventing wafte, by having a fhallow trough below, and above large deep troughs with open bottoms, to let the food pafs as it is confumed from the trough below. When liquid food is employed the lower trough may be of ftone, as feen at A.

Fig. 10. Is a potatoe fet fcoop invented by Mr. Slark, by which much of the fubftance of the potatoe may be faved.

Fig. 11. Is the Dublin potatoe fet fcoop for the fame purpofe.

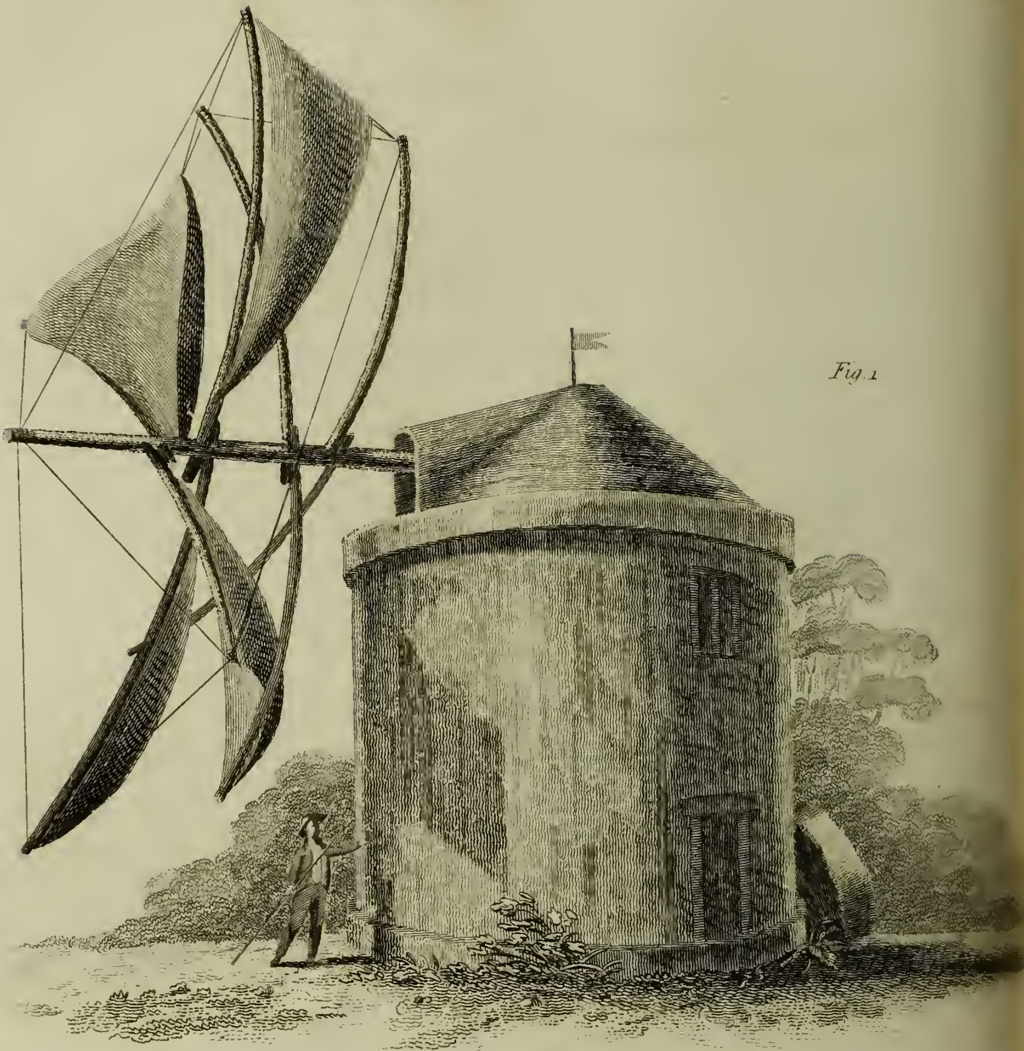


Fig. 1

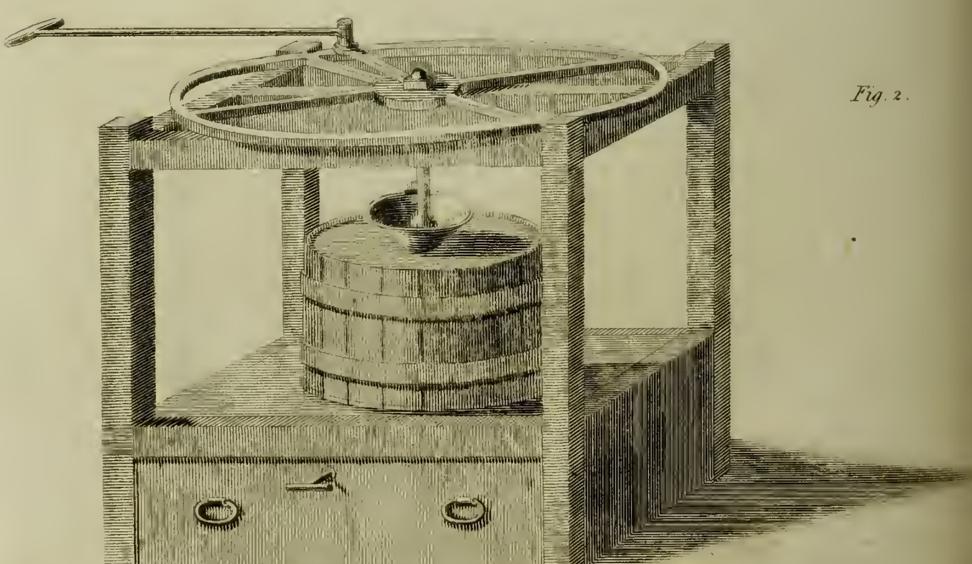


Fig. 2.

PLATE XXIV.

Mills.

[*To face Page* 64.]

Fig. 1. Is the reprefentation of a Windmill employed in Portugal, and which, from the differences in the conftruction of the fails, is fuppofed by Lord Somerville to poffefs a fuperiority in having the broad part of the fail at the end of the levers or booms, and confequently equal refiftance is overcome with lefs length of branches. And from this fhortnefs confiderable faving is made in the timber of both the booms and fpindles, as well as in the height, firft coft, and future repairs.

The advantages arifing from ufing mills of this defcription are, that as there are four booms, as well as four mafts for the fails, they are more eafily braced out to the wind, and in cafe of a fudden gale are more eafily caft loofe, than thofe of the common conftruction. And as the fails are placed in the beft poffible direction by means of the booms, it is prefumed that a mill built on this plan will do more work than any common mill with an equal quantity of canvafs.

Fig. 2. Reprefents a horizontal Hand Corn Mill invented by Mr. Wright. The frame is three feet fquare, and three and a half in height. The ftones are eighteen inches in diameter, and inclofed in the tub fupported by two crofs bearers; under which is a lever, having an iron pin or pivot, which runs through the centre of the bed-ftone, into a focket in the bridge of the upper ftone or runner, to which is attached the fhaft and fpindle, running through the eye of the runner and hopper, and fupporting the fly wheel and crank. A round piece of wood faftened on the fhaft ferves as a feeder; above is a fcrew to regulate the feed according as turned. On the fide of the tub is a thumb fcrew fixed to the lever underneath, which regulates the ftones according as turned. The fhaft runs through the crown tree or crofs bar at the top of the frame, on which is the horizontal fly wheel and crank; to which are attached one or two handles, by which the mill is put in motion. Under the ftones is a drawer, in which are placed three fieves of different fineneffes; one for taking away broad bran, another for the coarfe pollard, and the third for ftopping the fine pollard, and letting the flower pafs into the drawer; which is effected by a fort of iron fork running through a hole in front of the drawer, and fixing on one of the fieves.

The price of the mill is fixteen guineas, and one guinea for the fet of fieves.

PIGEON-HOUSES.

WHERE pigeons are bred for the purpofe of deriving profit from them, the pigeon-houfe fhould not only be large and roomy, but be placed in fuch a fituation that the pigeons may be fed with convenience, and without being dif-turbed by the different operations that are conftantly going on about the farm-houfe. The form of the houfe is probably not a matter of much confequence, provided it be not made too deep in the infide; pigeons difliking to have their nefts low down. The floor fhould be clofely laid, and the fides well plaftered, and white-wafhed over. The roof may be covered by any convenient and fuitable material, but tiles and flates are by much the beft; thatch being warm in winter and cool in fummer, may alfo afford a very good covering. The great objection to thatch for dovecoats is, that the pigeons are apt to fcratch it off; but when the ridge is fecured by ridge-tiles, and very light hurdles are laid on each fide of it, that inconvenience may be prevented. The whole muft be made perfectly fecure againft the entrance of rats and other vermin. Where buildings of this fort are quite detached from the other offices, it is, perhaps, the beft and cheapeft method to erect them on pillars of brick or ftone, or ftrong pofts of wood, about fix or feven feet high from the ground. In the latter cafe, the upper parts of the houfe may, likewife, be principally compofed of wood; and the under part will ferve as a fhed for various ufeful purpofes. If a ftable or cow-houfe the better, as it will have a tendency to keep the pigeons warmer in win-ter, which is material to their breeding early in the fpring, when they are of moft value in the market. The chief objection againft wood coats are, their being too cold in the winter, and too hot in the fummer months.

The apertures or openings for the entrance of the pigeons, fhould always have a fouthern afpect, as they delight in a funny fituation; and they ought not to be too large: the common fize is larger by much than is neceffary. The number of holes muft be regulated by the quantity of birds that are intended to be kept; it is better, however, to have too few than too many; as a great number of holes renders the dove-houfe cold, and in any cafe but few are made ufe of by the pigeons. Above thefe holes a piece of weather-boarding, fufficiently large for keeping off the wet, fhould conftantly be fixed up. Thefe boards are generally made fo fmall that they do not keep off the wet effectually.

It is the general practice to make fquare holes of board for the pigeons to lay and breed in; but a neater method is that of employing fmall wicker bafkets open at the top for this purpofe: thefe bafkets may either be compofed of finer or coarfer mate-

rials, according to the inclination of the builder, or the expence he wiſhes to be at. Neſts made in this way take up but little room, and are readily removed whenever it is neceſſary to clean them, eſpecially if they be fixed up in a convenient manner.

CONVENIENCES FOR PREPARING *CATTLE FOOD.*

On farms where a large ſtock is almoſt conſtantly either kept, or occaſionally fattened with different ſorts of prepared vegetables, it becomes an object of great importance to have ſuch accommodations as are proper and advantageous for performing the buſineſs.

STEAM-BOILERS.

The practice of boiling, what may be termed the artificial food of animals, in ſteam, though extremely advantageous, not only in the ſaving of time and expence, but in promoting the condition and feeding of them, has hitherto been, perhaps, too little attended to. Potatoes are the kind of food moſt generally prepared in this way, and the method of doing it is perfectly ſimple and eaſy. It conſiſts in having a ſhallow iron kettle of about twenty inches diameter, and ſeven or eight inches deep, ſet over a furnace, and ſo fitted into brick-work or ſolid ſtone, as to be perfectly cloſe on every ſide. To the top of this kettle, a tub, having its bottom perforated with a number of ſmall augre holes, is adapted, the kettle being previouſly half filled with water. Potatoes muſt then be put into the caſk, and the joining betwixt it and the kettle be well ſecured by a luting of clay. A cloſe cover, provided with a proper air-hole, muſt then be put on, and the potatoes be ſteamed by making the water in the kettle boil. When ſufficiently done, which may be known by removing the lid, they may be taken out by means of a proper ſhovel, or the caſk may be turned and emptied into a barrow, or any other ſuitable convenience for receiving them; and a freſh quantity again introduced, if neceſſary.

The conſtruction of this boiler is extremely plain and eaſy; but other apparatus for the ſame purpoſe may be readily contrived, ſo as to ſuit the moſt extenſive farms. They might be ſo conſtructed, indeed, as that the ſteam from one kettle would be ſufficient for ſteaming ſeveral caſks of potatoes at the ſame time; and inſtead of ſuch caſks as theſe, large fixed boilers with moveable bottoms, ſo as to let out the potatoes upon proper vehicles being placed under them, might be employed. Caſks ſuſpended on cranes, with ſlides in their bottoms for emptying them by, would, perhaps, be a

ftill more convenient contrivance. An ufeful apparatus of this fort is made by Mr. Cook.

If boilers of this kind be fituated near to the kitchen, they may be conveniently made ufe of for many purpofes of the family.

CORN-CHESTS.

It is equally convenient and economical for the ftable of even the common farmer to be provided with accommodations of this fort; much time as well as wafte of corn being faved by it. Befides, many other fubftances can, by fuch means, be kept ready mixed with the corn; fuch, for inftance, as cut ftraw, fplit beans, and feveral other articles that may be advantageoufly employed in the feeding of horfes. A common bin or tub may, in fome cafes, be fufficient for the purpofe; but on large farms, and where there is convenience, it is by much the beft to have them conftructed on the principle of the granary, which has been already defcribed. Where this plan is adopted, the form fhould be cubical, the bottom being made fomewhat in the manner of a hopper, with a flider fo contrived as that it may ftand about eighteen inches from the floor, by which means fufficient room will be given for taking out the provender. The fpouts may be fixed from fide to fide with great eafe and facility, and the air-holes be well fecured by a grating of iron wire. If it fhould be thought neceffary, the flide may be faftened by means of a fmall lock and key.

CORN-STANDS.

Where the very beneficial and advantageous cuftom of ftacking grain is practifed, it will be neceffary to have proper ftands or ftaddles provided for fecuring the corn, not only againft damp and moifture, but againft the deftructive wafte of rats and mice.

The mode of conftructing thefe ftands varies very confiderably in different fituations and diftricts. In fome places they are formed merely by placing two or three pieces of large timber length-ways, and then putting fmaller ones crofs-ways upon them. This is, however, a plan by no means to be followed, as it provides no fecurity for the bottom of the ftack. In other cafes, a ftrong framing of good timber is put upon pofts of wood, or what is better, of ftone about two feet high, provided with caps, on which it refts in a very folid and fecure manner.

But the moft fecure method is to have thefe fort of ftands walled, and well guarded by good copings. Corn-ftands, conftructed in this way, have lately been erected on the

farms of his Grace the Duke of Bedford, at Woburn-Abbey, whofe extenfive knowledge of the fcience of agriculture feems not lefs than his zeal in promoting its improvement. The foundations in making thefe ftands being funk a confiderable depth into the ground, and the bottoms well laid, vermin cannot get to the grain of the ftacks by working under them; and the upper part is rendered fafe by a projecting coping of ftone or wood. Subftances fhould not, however, be fuffered to reft againft them, or the loofe corn to hang down during the time of building the ftacks. In this way ftacks of the parallelogramical form may be built to any fize; but for fmall ftacks, efpecially where wood is employed, the octagonal form of ftand fhould rather be preferred to the circular one, as the copings may be cut with lefs wafte, and from fmaller timber; and it is juft as eafy to build a circular ftack on an octagonal ftand as on a circular one*.

Where ftone can be eafily procured, it is unqueftionably the moft proper material for the bottom; but brick, if properly made for the purpofe, anfwers very well, efpecially if proper care be taken in the laying of it. Slate, where it can be had at a reafonable expence, will be a very good fubftance for the fame purpofe. Flag-ftones would likewife anfwer extremely well; but neither flates nor flag-ftones are neceffary, if the foundation be laid fufficiently deep to prevent the vermin burrowing under it.

Stands of this kind were made ufe of by the late Mr. Bakewell, with much advantage; and other farmers, in the fame diftrict, probably employed them before him.

BEE-STANDS.

Although bees have hitherto feldom been much attended to by farmers as objects of profit, they certainly ought not to be overlooked in the fyftem of rural economy. But in order to turn their induftry to advantage, the farm muft be provided with proper and fufficient accommodations for them. Thefe are, perhaps, the moft convenient and leaft expenfive, when conftructed in the form and manner of flight fheds or ftands, and made of good feafoned wood, fo framed that the fore part of the fhed or ftand may be about fix or feven feet high, and the hind part five or fix. The top, and alfo the ends and back, muft be well covered with ftrong boards. The infide fhould, likewife, have a lining of very thin deal boards, and be furnifhed with ftrong fhelves, fo proportioned as to fuit the number of hives, boxes, or glaffes, that are to be placed in them. To the front, which is open, thin

* Communications to the Board of Agriculture, vol. I.

wooden fhades fhould be fo fixed and contrived, that they may be raifed and depreffed at pleafure, in order to protect the bees both from the too powerful effects of the fun and the rain.

The apiary, or bee-houfe, fhould always be placed in fuch a fituation as not to be much expofed to winds, as thefe animals are liable to be very much difturbed by them. It fhould likewife, if poffible, be near to water, and plenty of early blowing flowers, fuch as flower-gardens, turnip, muftard, and bean fields, &c.

SITUATION AND *ARRANGEMENT* OF *FARM-HOUSES* AND *OFFICES.*

Having thus diftinctly confidered the houfes and different forts of buildings which are neceffary for the comfort and convenience of various kinds of farming, we fhall proceed to fhew the fituations and arrangements which promife the moft advantage in refpect to the economy of human labour, the faving of expence in the conftruction, and the prevention of wafte in the articles which they contain.

Where a choice of fituation can be had for the farm-houfe and offices, it fhould certainly be as near as poffible to the centre of the farm, and rather elevated, by which means the various kinds of produce, as well as the manure of the farm-yard, may be conveyed to their proper deftinations with the greateft facility and difpatch; it fhould likewife be dry, well fupplied with water, and the approach eafy and convenient.

The three moft expofed fides of a fquare fhould always, where it is poffible, be chofen for the fituations of the different offices; that to the fouth being left free and open for the admiffion of fun and air.

Thefe circumftances, however important they may be, feem to have been little regarded in the building of farm-houfes in general, as we frequently find them occupying not only the worft, but the moft inconvenient fituations that the farms afforded. Where the form of the ground and other circumftances are favourable, and readily admit of purfuing any defign, the moft pleafing, though by no means the beft, fituation for the farm-houfe, is that of the middle of a regular front. It is always much better to have it at a fmall diftance from the offices and the farm-yard; from fifteen to twenty feet at each end will, in general, be fufficient. Where uniformity is particularly attended to, thefe fpaces may be occupied by naked walls, or what is better, a fort of lean to fheds may be formed from them for various ufeful purpofes. It is alfo frequently neceffary in the defigns of farm-houfes, and other buildings, that the daily tranfactions of fervants and labourers about fuch houfes and offices fhould at once be overlooked and examined. With this view

the common fitting or work room fhould have fuch a pofition, as that the bufinefs of the houfe may be readily feen from fome one part of it, while that of the farm-yard and out-buildings may be attended to from another.

In difpofing and connecting the different buildings and offices, much attention is likewife required, in order that they may be convenient and fuitable to the particular bufinefs of the farm. The nature of the fituation, and the ftate of the ground, will for the moft part afford the beft directions for placing the drains and other conveniences for taking off the fuperabundant moifture, as well as the proper place for depofiting the dung and collecting the urine into; and thefe again will, in a great meafure, fhew where the ftables, cow-houfes, feeding-fheds, root-houfes, and other offices relating to them, fhould be fituated. The barn fhould obvioufly be at no great diftance from them; adjoining to which, on the fides, fhould be the barn-yards and ftraw-fheds, the two ends forming the ftraw-yards and ftack-yards. In every cafe, perhaps, the ftables fhould be as much as poffible detached from the other buildings, in order that they may be the more fecure from fire. The granary, where neceffary, fhould always be near the barn, or even in it; if a threfhing-machine be erected, it may be very conveniently placed over it. The dairy fhould be diftributed in fuch a way, that it may be equally convenient to the dwelling-houfe, and the cow-houfes and yards, and at the fame time be as little as poffible expofed to either exceffive heat or cold. The hog-fties, as well as the poultry-yards, fhould, in order to avoid labour, be near to the dairy, yet not fo very near as to incommode it.

The diftribution of the inferior fort of buildings and conveniences muft be regulated by the particular circumftances of the fituations; but the principal and leading confideration, in directing every building, fhould be the bufinefs for which they are deftined, and the faving of time, labour, and trouble, in the performance of that bufinefs, by giving them the moft fuitable connection and diftribution *.

The nature and arrangement of the houfes and buildings proper for the accommodations of farmers being thus explained, we may offer a few obfervations on the expence at which they may be conftructed. This is, however, a point on which it is difficult to fpeak with much precifion, as various circumftances, in refpect to the fituation and facility of procuring materials, muft obvioufly make confiderable differences in all fuch eftimates; befides, the prices of materials, as well as labour, have confiderable local variation; but, as far as any general rule will apply on fuch fubjects, it is probable that, provided the farm be not under fixty or feventy pounds a-year, one, or, at fartheft, two years' rent, will be fully adequate to the building of

* Beatfon in Communications to the Board of Agriculture, vol. I.

DAIRY FARM HOUSES & OFFICES.

Fig. 1.

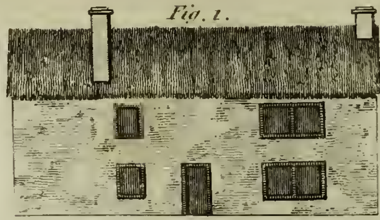
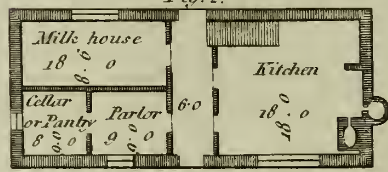


Fig. 2.



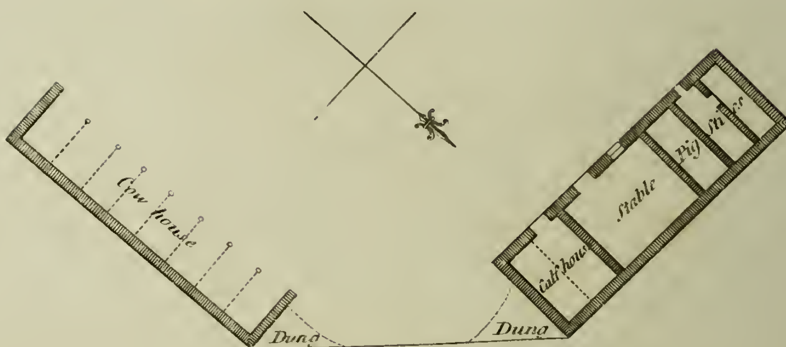


Fig. 3.

Fig. 4.

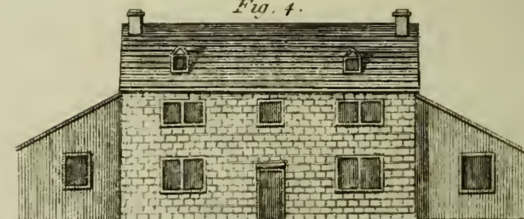
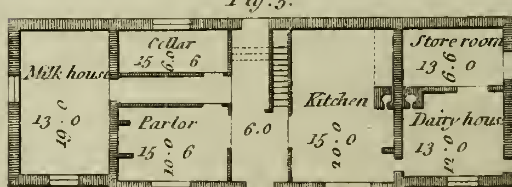


Fig. 5.



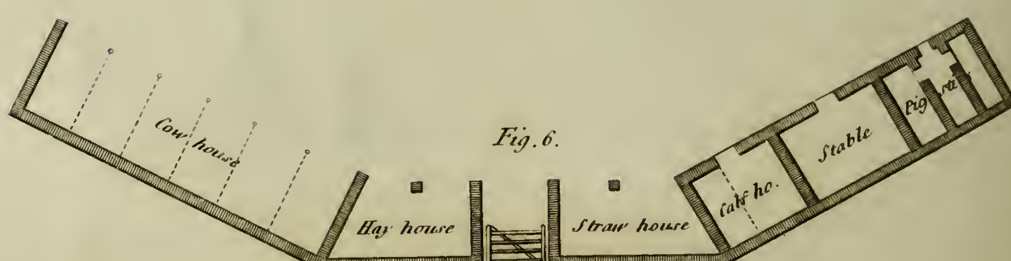


Fig. 6.

PLATE XXV.

Dairy-farm Houſes and Offices.

[*To face Page* 71.]

AT *Fig.* 1. is repreſented the plan and elevation of a farm-houſe on a ſmall ſcale where dairying is practiſed.

Fig. 2. Is the ground plan.

Fig 3. Shows the ſituation and connection of the ſheds and other out-buildings.

And at *fig* 4. is exhibited the plan and elevation of another farm-houſe on a more extenſive ſcale, for the ſame management.

Fig. 5. Shows the ground plan.

Fig. 6. Explains the nature and arrangement of the different buildings for the uſe of the cattle, &c.

Theſe houſes and offices are on the plan of Mr. Crocker, and deſigned for farms of from 60l. to 200l. a year, when the principal object is the dairy.

every office, independent of the houſe which is required for ſuch farms; and on all farms, of from three to four hundred pounds a-year, one year's rent, or even much leſs in particular caſes, will be ſufficient for building the dwelling-houſes: and probably on farms of any extent, five hundred pounds is an ample allowance for the dwelling-houſes, and one thouſand or twelve hundred for the reſpective offices. Various uſeful and convenient plans and eſtimates of farm-houſes and offices have been propoſed, for farms of different kinds, by Mr. Crocker, in a paper in the firſt volume of Communications to the Board of Agriculture. For thoſe which are wholly of the dairy kind, his eſtimates are theſe:

DAIRY-FARMS.

For a dairy-farm, of from ſixty to one hundred pounds per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, furnace, &c. - -	58	10	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c. -	92	17	0
Plaſterer, for ceiling, rendering, and plaſtering - - - -	16	3	0
Smith, for locks, hooks, and twiſts, latches, &c. - - - -	3	5	0
Glazier - - - -	10	6	0
Thatcher - - - - -	8	13	0
Painter - - - -	0	12	0
	£190	6	0

Out-Houſes.

	£.	s.	d.
Maſon, for walls of the cow-houſe, calf-houſe, ſtable, pig-ſty, &c. -	28	3	6
Do. for pitching or paving do. -	8	5	0
Carpenter, for roofs to the cow-houſe, calf-houſe, ſtable, pig-ſties, &c. - - - -	15	16	6
Do. for floors of hay-loft, doors, rack, and manger, &c. - -	12	18	6
Thatcher - - - -	7	10	0
Smith, for locks, &c. - -		16	6
Neceſſary-houſe - - -	1	15	0
	75	5	0
Total	£265	1	0

For a dairy-farm, of from one hundred to two hundred pounds per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, ovens, furnace, &c. - -	92	4	6
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c. -	114	10	6
Plaſterer, for ceiling, rendering, plaſtering, and tiling - -	53	11	0
Smith, for locks, hooks, and twiſts, &c. - - - -	3	10	0
Glazier - - -	15	13	0
Painter - - - -	0	18	0
	£280	7	0

Out-Houſes.

	£.	s.	d.
Maſon, for walls of the cow-houſe, calf-houſe, ſtable, &c. - -	31	15	6
Do. for pitching do. - - -	8	5	0
Carpenter, for roofs to the cow-houſe, ſtraw-houſe, hay-houſe, ſtable, calf-houſe, and pig-ſties	17	12	6
Do. for floors of hay-loft, doors, calf-houſe, rack, &c. - -	10	18	6
Thatcher - - -	6	13	0
Smith - - - -	0	11	0
Neceſſary-houſe to be placed in the garden - - - - -	1	15	0
	77	10	6
Total	£357	17	6

Thoſe that are entirely employed in the growth of grain requiring more extent of buildings, the eſtimates of courſe ſtand conſiderably higher:

CORN-FARMS.

For a corn farm, of from one hundred to two hundred pounds per annum.

Houſe.	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, furnace, &c. - -	94	11	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c. -	125	3	3
Plaſterer, for ceiling, rendering, and plaſtering - - -	25	11	8
Tiler - - - -	35	10	0
Smith - - - -	2	18	0
Glazier - - - -	14	14	0
Painter - - - -		18	0
	£299	6	7
Out-Houſes.			
Maſon, for walls of the cyder-houſe, ox-ſtalls, barns, ſtable, waggon-houſe, and granary, and for pitching - - - -	80	7	0
Carpenter, for roofs, &c. -	66	12	3
Do. for floors, of do. and for rack, manger, windows, &c. - -	79	16	0
Thatcher - -	25	0	6
Tiler - - - -	11	5	0
Ceiling the granary - -	1	13	4
Smith - - - -	3	3	0
Neceſſary-houſe - - -	2	10	0
	270	7	1
Total	£569	13	8

For a corn farm, of from two hundred to three hundred pounds per annum.

Houſe.	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c. - - -	139	5	4
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, ſtairs, &c. - -	154	4	8
Smith, for hooks, &c. &c. -	4	12	0
Plaſterer and tiler - - -	84	7	2
Glazier - - - - -	19	9	0
Painter - - - - -	1	15	0
	£403	13	2
Out-Houſes.			
Maſon, for walls of pig-ſties, ſtraw-houſe, ſtables, barn, waggon-houſes, granary, and for pitching - - - -	107	15	0
Carpenter, for roofs - -	87	7	0
Do. for floors of granary, hay-loft, barns, and for rack, manger, &c.	85	2	6
Thatcher - - - -	40	14	0
Tiler, for the granary and for ceiling it - - -	6	13	6
Smith, for locks, &c. - -	3	7	0
Neceſſary-houſe - -	2	12	6
	333	11	6
Total	£737	4	8

CORN FARM HOUSES & OFFICES.

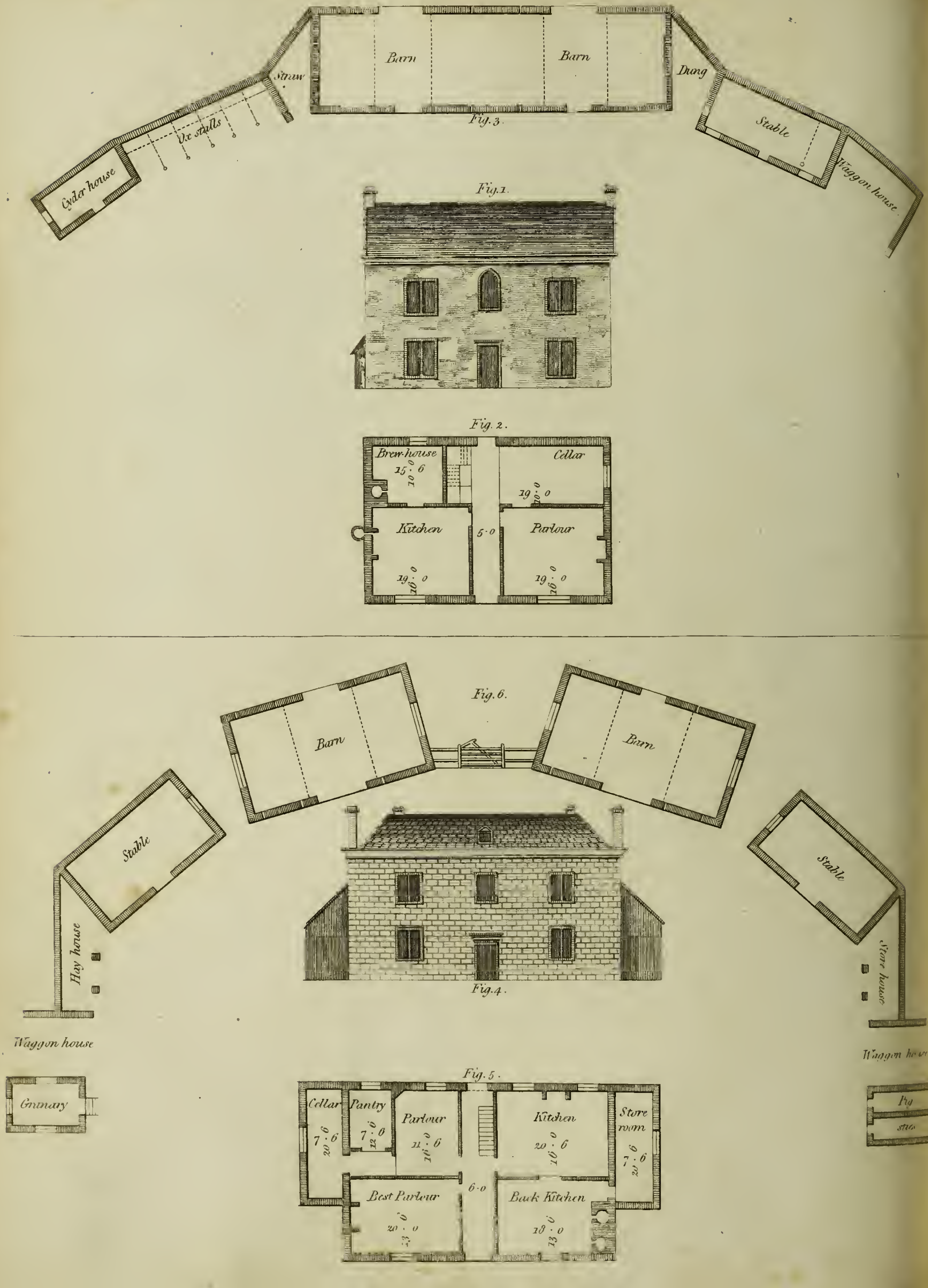


PLATE XXVI.

Corn Farm Houfes and Offices.

[*To face Page* 72.]

AT *Fig.* 1. is feen the plan and elevation of a fmall farm-houfe.

Fig. 2. Shows the ground-plan.

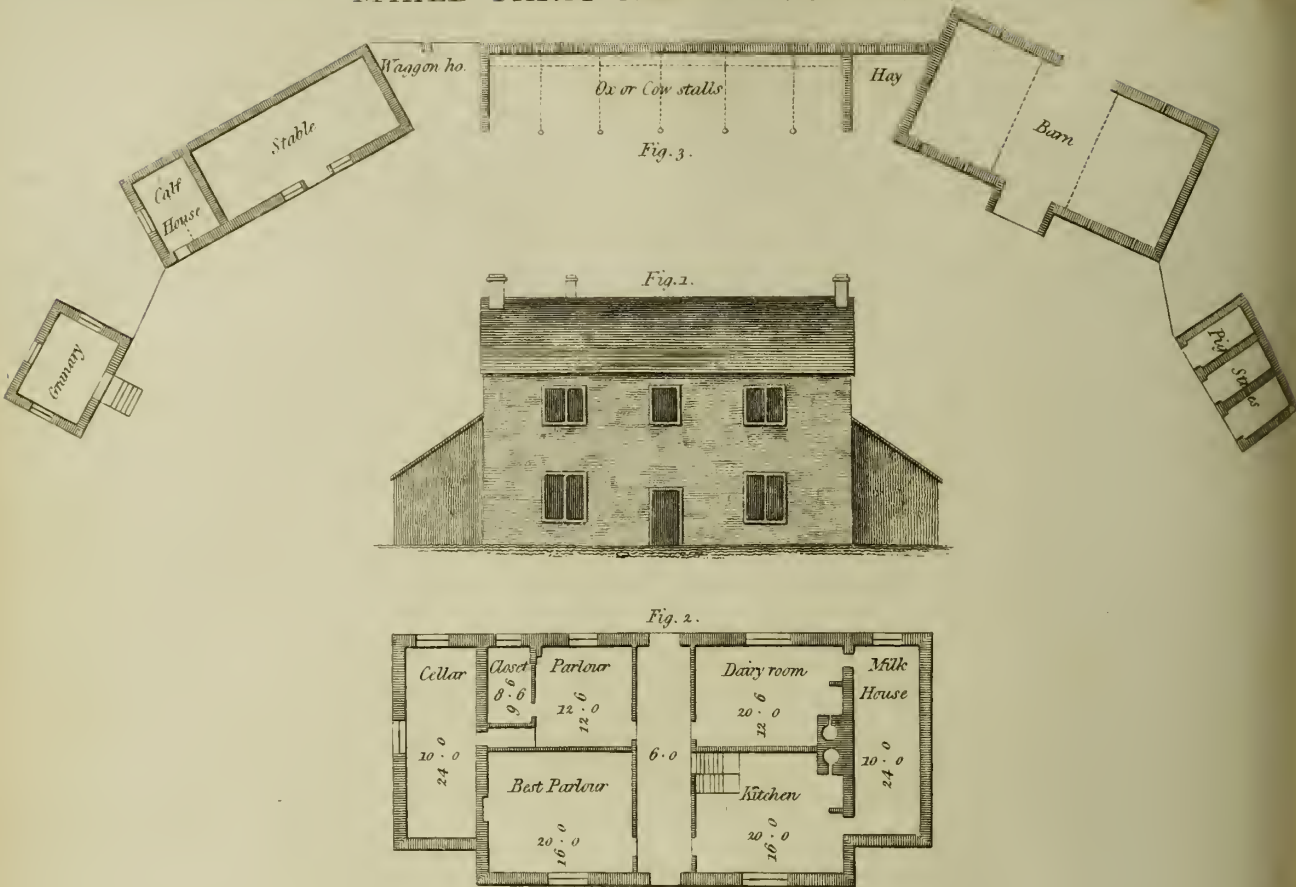
Fig. 3. Exhibits the arrangement of the various offices neceffary for a fmall farm, where the produce is chiefly grain.

At *Fig.* 4. is a reprefentation of the plan and elevation of a farm-houfe on a larger fcale. *Fig.* 5. the ground-plan of the fame.

Fig. 6. Shows the diftribution of the feveral out-buildings that may be requifite for the farm.

Thefe plans are recommended by Mr. Crocker ; as calculated to ferve grain-farms of from one hundred pounds to three hundred pounds a year.

MIXED FARM HOUSES & OFFICES.



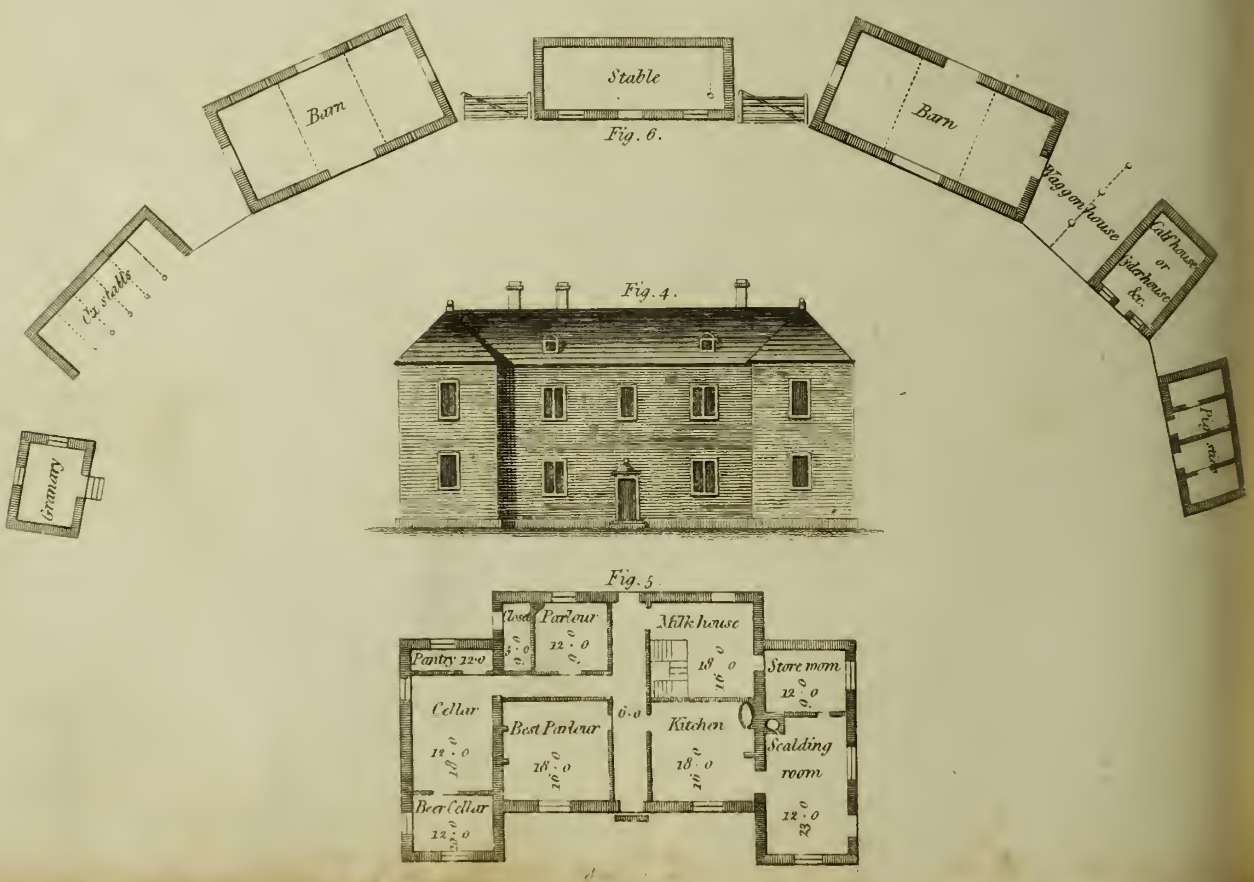


PLATE XXVII.

Mixed Farm Houſes and Offices.

[*To face Page* 72.]

AT *Fig.* 1. is exhibited the plan and elevation of a farm-houſe, where different ſorts of management are carried on upon a moderate ſcale.

Fig. 2. Is the ground-plan.

Fig. 3. Explains the nature and arrangement of the various out-buildings: and at

Fig. 4. is ſhown the plan and elevation of a farm-houſe on a more extenſive ſcale, but adapted to the ſame ſort of management.

Fig. 5. Is the ground-plan.

Fig. 6. Shows the ſituation and diſtribution of the ſeveral out-buildings.

Theſe houſes and buildings are adapted to farms where a mixed ſort of huſbandry, as arable and dairy, is practiſed, and which extend from two hundred to four hundred pounds a year. They are after deſigns by Mr. Crocker.

There are others, which partake both of the nature of the corn and the dairy farm, in which a variety of buildings muſt of courſe be required; the eſtimates for theſe are conſequently ſtill higher:

MIXED FARMS.

For a corn and dairy farm, of from 200 to £300. per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c. - - -	147	7	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, ſtairs, roof, &c. -	142	19	6
Plaſterer, for rendering, plaſtering, &c. - - - -	44	6	0
Smith, for locks, &c. - - -	5	10	0
Thatcher - - - - -	16	10	0
Glazier - - - -	21	6	0
Painter - - - - -	2	0	0
	£379	18	6

Out-Houſes.

	£.	s.	d.
Maſon, for walls to the granary, calf-houſe, ſtable, ox-ſtalls, pig-ſties, and for pitching -	71	12	0
Carpenter, for roofs to granary, calf-houſe, ſtable, waggon-houſe, ox-ſtalls, barns, pig-ſties, &c. and for floors to granary, barns, &c. &c. - - - -	102	17	0
Thatching, tiling, and ceiling the granary - - - -	33	12	6
Locks, &c. - - - - -	3	8	0
Neceſſary-houſe - - -	3	13	6
	215	3	0
Total	£595	1	6

For a corn and dairy farm, of from 300 to £400. per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c. - - -	143	11	0
Carpenter, for lintels, window-frames, beams, and joiſts, partitions, ſtairs, roof, &c. -	172	5	0
Plaſterer, for rendering, plaſtering, and ceiling do. - - -	69	0	0
Smith - - - -	6	5	0
Glazier - - - -	26	0	0
Tiler - - -	63	0	0
Painter - - - -	2	10	0
	£482	11	0

Out-Houſes.

	£.	s.	d.
Maſon, for wall of granary, cow-houſe, barns, ſtables, cyder-houſe, and pig-ſties, and for pitching	123	9	6
Carpenter, for roofs of granary, cow-houſe, barns, ſtables, waggon-houſes, cyder-houſe, &c. and for floors of granary, barn, and hay-loft, corn-binns, &c. &c.	122	0	6
Thatcher - - - -	24	4	0
Tiling and ceiling the granary -	6	16	0
Smith - - - -	3	8	0
Neceſſary-houſe - - -	3	19	0
	283	17	0
Total	£766	8	0

In the conſtructing of new farm-houſes and buildings great ſavings may always be made where there are old erections, by making uſe of different kinds of old materials which are produced from them *.

* Beatſon's Communications to the Board of Agriculture, vol. I.

As all buildings of this fort fhould be made as durable and lafting as poffible, the materials that are employed fhould always be of the beft kinds. It is remarked by an intelligent practical writer, that " tiles or flate are the beft covering for houfes; but barns and ftables fhould be thatched, becaufe workmen are always carelefs, in laying corn and hay into them, and generally pufh the tiles off with their prongs; and befides, thefe buildings, when empty, collect a great deal of wind, which is apt to diflodge them, unlefs they are pointed in the infide, which increafes the expence confiderably, and is never lafting. Reed is the beft of all covering for barns, ftables, cart-houfes, &c. There is, he fays, a fort of reed which grows in fens, marfhes, and wet-lands, fo excellent for this ufe, that a moderate coat, if it be well laid on, will endure at leaft half a century, with very little expence of reparation: and it is a fact beyond contradiction, that the timber ufed in roofing will laft thirty years longer when covered with reed, than it will when covered with tiles. The next beft covering to this is, he thinks, the *Somerfetfhire-reed;* which is nothing more than the ftrongeft wheat-ftraw which can be met with, combed clean from weeds, having the ears of the corn cut off, inftead of being thrafhed, and fo laid on upon the building in whole pipes, unbruifed by the flail. This latter reed may be had in any other county, as well as *Somerfetfhire*, in fufficient quantity; and it is abfurd, in the laft degree, he fays, to make ufe of ftraw for thatching in any other way, becaufe the difference of expence in the preparation is a mere trifle, compared with the difference of duration between the *Somerfetfhire thatch* and that of other counties. The common, injudicious, flovenly practice of beating the ftraw to pieces with the flail, and then laying it on with fome of the feeds and many weeds in it, caufes it very often to grow quite green, after it is laid upon the building; and being bruifed in all parts, to collect and retain the wet, much more than it would if the ftraw were whole, and confequently to become quite rotten in a few years. When ftraw is defigned for thatching, it is a good way to cut the corn rather earlier than ordinary*."

Where tiles are employed, they fhould be well made, and kept well pointed with lime both on the infide and the out, as often as may be neceffary; as without attention in thefe refpects they form a very infufficient roofing for houfes, from their readily admitting rain and fnow.

In regard to the timber moft proper for building with, the author juft mentioned fays, " that he knows of none that is to be preferred to Spanifh-chefnut, where it can be had, becaufe it is very pleafant to work, and as durable as oak, though it feldom bears the price of it. In maritime counties, where oak fells well, and deals

* Kent's Hints, p. 149.

are tolerably cheap, it is beſt to diſpoſe of the one, and buy the other; becauſe oak is generally cut to waſte in moſt repairs, and deals may be bought of any ſcantling that may be required.

"In all paling, battoning, and other fences about the homeſtall, nothing is, he thinks, more uſeful than pollards; and they ſhould always be made uſe of on ſuch occaſions, becauſe they are generally the produce of the farm, of little value, and ſave better timber. Sometimes they are uſeful in ſheds, and ſmall buildings, for cattle. Bricks are a very conſiderable object, and great care ſhould be taken in getting them of a good quality. Upon moſt eſtates, of any conſiderable ſize, brick-earth, or clay, may be met with; and, where this is the caſe, they may be always made, and burnt in clamps, for one-third leſs than they can be bought at the kilns, and equally good in quality. He has had a great number burnt in this manner, from eleven to fourteen ſhillings a thouſand, in different counties. The medium price is twelve ſhillings a thouſand where fuel is reaſonable. Beſides the difference in price, there is generally a great ſaving in carriage, when gentlemen burn their own bricks. No material in building requires greater inſpection than mortar, in which maſons are apt to be deficient. Two things are to be attended to: the quality of the different articles, and the manner of mixing them."

It has been well obſerved, by another practical writer, who ſeems to have examined the ſyſtems of farming carried on in different diſtricts with conſiderable attention, that though, in general, "the ſize of the farm, and the ſyſtem of huſbandry adopted, muſt regulate the extent as well as the ſort of buildings to be erected; yet, in order to introduce and carry on ſpirited agriculture, ſufficient accommodation in regard to houſes is neceſſary. Accordingly he has found, that in every part where the proprietors are negligent in furniſhing their tenants with proper farm-buildings, or granting a reaſonable allowance for that purpoſe, agriculture, as well as all the other branches of huſbandry, remains in a languiſhing ſtate. But that, on the contrary, wherever ſubſtantial and commodious farm-offices have been built, whether at the expence of the proprietor or tenant, improvements in agriculture have always ſucceeded*."

This not only ſhews the great advantage of having proper buildings, in ſo far as they reſpect the management of the farm, but that they have likewiſe conſiderable influence in promoting the improvements of huſbandry.

* Donaldſon's Modern Agriculture, vol. II. p. 42.

SECTION III.

Farm-Cottages.

COTTAGES—Building of, important to Agriculture—Promotes the Intereſt of the Farmer and Land Proprietor—Advantages of, as explained by different Writers—The Aſſiſtance of Cottagers neceſſary to the Farmer—The Utility of connecting ſuch Buildings with Farms—Uſeful in other Points of View—Moſt expert Labourers in Huſbandry produced by this Means—Without them much Time frequently loſt—Farmers often injured—Advantageous to have many on Farms—May ſometimes be beneficial for Tenants to build, or aſſiſt in building them—Condition of Labourers thus much benefited—Their Habits rendered more regular—More diſpoſed to perform the Buſineſs of Cultivation—Neceſſary to remove all Obſtacles to the Erection of—They promote Population—Uſeful for the Farmer to be more intimately connected with Cottagers—Proper Regulations ſhould exiſt between them—Advantages of ſuch a Mode—Should have Portions of Land annexed to them—Utility of ſuch a Plan—How it may be effected—Different Situation of Labourers conſidered—Earl of Winchelſea's Obſervations on them—Difference of Cottagers that have Land, and thoſe that have not—Neceſſity of improving their Cottages, ſhewn—Certain Regulations neceſſary when Land is annexed to them—Should be held in the Poſſeſſion of the Proprietors—When held by the Farmer injurious to the Cottager—Conſtruction of different, according to Circumſtances and Purpoſes—For the farming Labourer, Plainneſs, Simplicity, and Convenience, only neceſſary—The miſerable Hovels they ſometimes inhabit, highly diſguſting—Situation of, little attended to—Should be rather elevated, not high—Should be near the Farm—Circumſtances to be attended to in the Ground Floors of—In other Parts of—Size of various—Modes of dividing the Rooms in different Inſtances—Economical Modes of placing the Stairs—Mr. Kent's Opinion of their Accommodations—Beſt Forms of—Circular Plan objectionable—Building two or more together ſaves Expence.—Upper Rooms neceſſary for the Preſervation of Health—Attention to Warmth neceſſary in Conſtruction of—Conveniences for free Circulation of Air, uſeful—Means of preventing exceſſive Heat in Summer—Cheap Methods of covering them—Thatch—Reed—Stubble—Pitched Paper, mentioned by Mr. Bateſon—Circumſtance to be regarded in Materials for Building with—Should always be White-waſhed in ſuch Caſes—Methods of proceeding where earthy Subſtances are employed—Manner of laying the Floors—Materials proper for—Reaſons why Plaſter is uſeful—Saving of Fuel to be attended to in Conſtruction of—Means of accompliſhing—Builders ſhould attend more to Philoſophical Principles—Particulars to be regarded in Reſpect to Water in—Mr. Holland's Opinion of—Various Advantages of Sheds, and

Privies in—Expences of, vary according to Circumſtances—Different Eſtimates of—Of double Brick Cottages—Of ſingle ones—Of Stud and Mud ones—Particulars in the Management of—Different Obſervations on.

HOWEVER much the building and providing of ſuitable accommodations for farming labourers may have been neglected or unattended to, it is evidently a ſubject of conſiderable intereſt to agriculture, and upon which, perhaps, much of its ſucceſs and improvement depends. It has been well obſerved by an able writer, that without hands, for the purpoſe of cultivation, eſtates are of no value; conſequently, the farming labourer is one of the moſt important members of ſociety: without his aſſiſtance the beſt and moſt fruitful ſoil is not worth poſſeſſing; his condition ſhould, therefore, if it were only out of good policy, be rendered more eaſy andcomfortable. If no other motive ſhould operate in the promotion of this purpoſe, the intereſt of the farmer and land proprietor of every deſcription evidently, he thinks, demands it*.

The advantages of letting perſons of this claſs comfortable cottages with gardens, and ſmall plots of graſs land adjoining them, as far as it reſpects themſelves, have lately been well explained by the judicious enquiries of ſeveral noble authors†. And that ſuch a plan would be equally, if not more beneficial to the farmer, there can be little doubt. For it is obvious, that though he may have a certain number of labouring people conſtantly about him, they will not be able, on every occaſion, and in every place, to perform all the buſineſs that is neceſſary on his farm. He muſt, therefore, either be under the neceſſity of keeping more ſervants than are abſolutely requiſite, at great expence, or he muſt have recourſe to the aid of the cottage labourer. This clearly proves the importance of cottages being connected with farms. But this is, however, far from being the only point of view in which it is important; it is moſtly from amongſt this claſs of men, that the beſt and moſt expert labourers in the buſineſs of huſbandry are procured; being, in general, inured from their infancy to ſuch labours, and accuſtomed to perform the different operations of farming, they are enabled to manage the practical part of agriculture with much eaſe and readineſs, which is far from being the caſe with the common labourer, who, for the moſt part, has been brought up to ſome other occupation or employment. Beſides, on ſuch farms as are at ſome diſtance from towns and villages, theſe

* Kent's Hints.

† Earl of Winchelſea, Lord Brownlow, &c. in Communications to the Board of Agriculture, vol. I.

accommodations for labourers feem indifpenfably neceffary, as without them much time muft, of courfe, be loft in going backwards and forwards to their different meals, and the places in which they lodge; and from the unavoidable fatigue that attends this mode, they are little difpofed to procure work at a dif-tance, if they can poffibly get it at the places where they refide, which in many fituations often reduces the farmer to much inconvenience, if not actual lofs. Where, therefore, the fyftem can be introduced with convenience, and a mutual intereft be eftablifhed between the farmer and the labourer, it will be to the advantage of the former to have as many cottages on his farm as poffible; and under fome circumftances, as in cafe of long leafe, it may even be advantageous for him to build them, or at leaft affift the proprietor in doing it, by the con-veyance of materials, and other fuch means as are in his power.

In this way, the condition of the labourers in agriculture would be confi-derably improved; their means of living be rendered more certain and eafy; their habits more regular and induftrious; and their difpofitions, in general, probably more favourable for the bufinefs of cultivation.

But, in order the more readily and effectually to promote and accomplifh a matter of fo much confequence to agriculture, every obftacle fhould be removed out of the way which has the leaft tendency to retard the erection of fuch buildings; whether arifing from old acts of parliament made under very differ-ent circumftances from the prefent, or parochial and other regulations of a more local nature.

It has been a remark of great antiquity, that nations are rich in proportion to their population; and fo an able writer, on the fubject of cottages, obferves "it is in a great meafure with an eftate or a farm, for the more numerous its inhabitants, the more eafily will it be cultivated and improved. The erection of cottages is, therefore," fays he, "an object of great importance to the farmer, as well as to the proprietor; but it is neceffary for the mutual advantage of both parties, that the landlord and his cottagers fhould be on the beft of terms; that he fhould regard them as part of his own family, and that they fhould look up to him as their beft and fureft friend and protector. Every cottager fhould, therefore, confider, that in promoting the interefts of his landlord, whether proprietor or tenant of the farm, he is at the fame time promoting his own; for a landlord has it much in his power to ferve and oblige his cottagers in various ways, as they themfelves muft be fenfible of*."

* Beatfon in Communications to the Board of Agriculture, vol. I.

With a view to render the building of habitations for the labourers in huſbandry, not only more agreeable, but more advantageous to the different parties; it would, perhaps, in many caſes, be uſeful to have ſuitable conditions ſtipulated between them, by which the landholder ſhould be ſecured for the labour of his tenant, when neceſſary, upon fair and equitable terms, while the labourer is made certain of his reſidence, on the due performance of them. In regard to payment of rent, on ſome occaſions, it would, likewiſe, be extremely proper and convenient to have ſuch regulations as would ſecure its diſcharge in the moſt eaſy and leaſt oppreſſive manner. By adopting ſome ſuch plan as this, many diſagreeable diſputes, and much uneaſineſs, would frequently be prevented, and at the ſame time the cottager be enabled to perform his engagements with greater exactneſs, and far more comfort to himſelf.

That cottages, wherever it can poſſibly be done, ought conſtantly to have ſome portions of land annexed to them, ſeems generally allowed; but the mode of attaching it, and the quantity which is requiſite in different caſes, are matters of conſiderable difficulty, and which muſt, probably, depend on various local circumſtances, ſuch as the abundance or ſcarcity of land, the manner in which it is cultivated, and the diſpoſitions of the occupiers. In every ſituation, perhaps, a ſufficient quantity for the growing of proper vegetables for the cottager and his family may be ſpared, as for this purpoſe not more than twenty or thirty perches of ground will be required. It is, however, notwithſtanding this, well obſerved by the Earl of Winchelſea, in the valuable paper which we have already quoted, that the beſt ſituation for a labourer is that of his holding a ſufficient quantity of graſs incloſed land, for the keeping of one or more cows winter and ſummer, with a garden contiguous to the houſe; as in this caſe all the buſineſs is done by his wife, except that of making hay, and he is not taken off from his labour. This kind of allotment can, however, evidently only be made where graſs land is abundant.

The next ſituation in point of advantage, he conceives to be that in which the cottager has a ſummer paſture for his cow, and a portion of arable land upon which the winter proviſions are grown. In this caſe it is, however, obvious that too much of the labourer's time muſt generally be taken up by the management of his arable ground. Where, indeed, a part is ſown with artificial graſſes, it may not be ſo employed to any hurtful degree. On his lordſhip's eſtates this plan is found to anſwer very well. It is evident that this mode of diſtribution muſt be very narrow and confined in its operation, as it can only be had recourſe to in caſes where there is a mixture of arable and paſture grounds.

The third ſituation in reſpect to the benefit of the farming labourer, is that in which he has a right of common for the ſummer keep of his cow, and a meadow or arable land; or a meadow in common for the providing of winter food.

This, his lordſhip conceives, would be nearly equal to the two former, were it not that commons are ſo frequently overſtocked as to render the ſummer keep extremely bad; this is of courſe a great loſs, and if the meadow be in common too, the matter is ſtill worſe. He further remarks, that, "it is certain that upon an incloſure, if the owners chooſe it, the labourers who keep cows may be placed in a much better ſituation than they were, in as much as incloſed land is more valuable to occupiers of every deſcription, than commons and open fields. Garden ground may alſo be allotted to them and others, which cannot be done while the land remains unincloſed. I am perſuaded, continues he, that where theſe things are attended to, very few objections to an incloſure will ariſe on the part of the labourers, and that the land-owners will have the ſatisfaction of benefiting the poor, and at the ſame time of making their own property more valuable, by adopting, what, in all probability, will be the means of keeping down the poors' rate."

In theſe ſituations, gardens are always ſuppoſed to be near the houſe; but where they have more, or where the ground lies at ſome diſtance from them, the advantages cannot, by any means, be ſo great.

The fourth ſituation is that in which the labourer has a right of common, and a garden. This is highly beneficial, his lordſhip ſuppoſes, as geeſe and pigs may be kept upon the common paſture, and the latter be fed by means of the garden ſtuff, and a ſmall quantity of other food which can be eaſily procured by the cottager.

The fifth caſe is that in which the labourer has a right of common, but without a garden. This, he thinks, is obviouſly of little utility to him, unleſs in ſituations where fuel can be procured from it, in which caſe it becomes extremely valuable, and the loſs of which cannot be eaſily repaired.

The ſixth is that ſituation in which the labourer has ſome arable ground, but without any ſummer paſturage for his cow. This his lordſhip conſiders as of little uſe; for, ſays he, "though he may cultivate part of the land as a garden, the continued labour it would require to ſtall-feed a cow winter and ſummer, and the quantity of land he muſt till, would occupy ſo much of his time, that the *take* would, upon the whole, be injurious to him, even ſuppoſing the land incloſed,

and contiguous to his houfe; and if at a diftance, or not inclofed, the difadvantage would be ftill greater.

The feventh fituation of the cottage labourer is that in which he has merely a garden adjoining his habitation. This his lordfhip confiders as the beft thing that can be done for labourers in arable countries; as lands cultivated in this way afford a much greater quantity of food for man, than when managed in any other manner. Befides, the greateft part of the work is done at fuch times as the labourer and his family can conveniently fpare from their more particular employments.

The laft, and by much the worft, fituation, is that in which the labourer has no land whatever. Under this circumftance he cannot, his lordfhip thinks, be fo comfortable to himfelf, or have the means of making his children acquainted with that kind of labour and knowledge which is effentially neceffary for them. "When a labourer is poffeffed of cattle," fays the able author of the paper we have before mentioned, "his children are taught early in life the neceffity of taking care of them, and acquire fome knowledge of their treatment; and if he has a garden, they learn to dig and weed, and their time is employed in ufeful induftry, by which means they are more likely to acquire honeft and induftrious habits, than thofe who are bred up in the poverty and lazinefs we too often fee; for I believe," continues he, "it is a certain fact, that extreme poverty begets idlenefs."

Thefe interefting obfervations clearly fhew that on fuch grounds there cannot be any doubt of the advantages of farming labourers poffeffing fmall portions of land, or at leaft gardens. It is a fyftem which tends not only to benefit them, but which, at the fame time, muft greatly contribute to the intereft of the owners of land, and the community in general. Such a plan cannot, indeed, from various local caufes, be generally introduced, but it may be rendered much more common and extenfive than it is at prefent, fince the narrow, confined, and illiberal notions, which have fo long retarded its execution, have now been fully fhewn to be erroneous and ill founded. It is well obferved by the noble author we have fo frequently mentioned, that, "in countries where it has never been the cuftom for labourers to keep cows, it would be very difficult to introduce it; but where no gardens have been annexed to the cottages, it is fufficient to give the ground, and the labourer is fure to know what to do with it, and will reap an immediate benefit from it."

The advantages of gardens are alfo great, in refpect to the labourers themfelves, as the attention they require prevents them from vifiting the ale-houfes. The

Rev. Mr. Townſend has ſomewhere well remarked, that "there is a ſtriking difference between the cottagers who have a garden adjoining their habitations, and thoſe who have no garden. The former," ſays he, "are generally ſober, induſtrious, and healthy, whilſt the latter are too often drunken, lazy, vicious, and frequently diſeaſed."

When lands are let to labourers, it would ſeem to be not only juſt, but advantageous, that they ſhould never be charged higher than the price at which the farmer has them; and that the cottages themſelves ſhould always be kept at the diſpoſal of the proprietor, and not be ſuffered to paſs into the hands of the tenants or holders of farms, as is too commonly the cuſtom, frequently to the injury and diſadvantage of the cottager.

Cottages may be conſtructed in different forms, according to the purpoſes for which they are deſigned, and the intentions of the builder; but in ſuch as are merely intended for the farming labourer, all, perhaps, that is required is, that they be plain, ſimple, neat, and convenient.

It has been remarked by an accurate obſerver, that "the ſhattered hovels which half the poor of the kingdom are obliged to put up with, are truly affecting to a heart fraught with humanity. Thoſe who condeſcend to viſit theſe miſerable tenements, can teſtify," he ſays, "that neither health nor decency can be preſerved in them. The weather frequently penetrates all parts of them; which muſt occaſion illneſs of various kinds, particularly agues; which more frequently viſit the children of cottagers than any others, and early ſhake their conſtitutions. And it is ſhocking that a man, his wife, and half a dozen children, ſhould be obliged to lie all in one room together; and more ſo, that the wife ſhould have no more private place to be brought to bed in. This deſcription," ſays he, "is not exaggerated, offenſive as it may appear. We are all careful of our horſes, nay of our dogs, which are leſs valuable animals; we beſtow conſiderable attention upon our ſtables and kennels; but we are apt to look upon cottages as incumbrances, and clogs to our property; when, in fact, thoſe who occupy them are the very nerves and ſinews of agriculture." Nay, he is bold to aver, that more real advantages flow from cottages, than from any other ſource; for, beſides their great utility to landed property, they are the greateſt ſupport to the ſtate, as being the moſt prolific cradles of population. He does not, however, wiſh to ſee the cottage improved, or augmented ſo as to make it fine, or expenſive; no matter how plain it is, he thinks, provided it be tight and convenient*.

* Kent's Hints,

The local ſituation of this ſort of cottage ſeems, in general, to have been too little attended to; it ſhould, however, be a dry, open, and rather elevated place, though by no means high, ſuch ſituations having many diſadvantages, with but few conveniences. Rather low ſituations, provided they be perfectly dry, and free from damp, are, perhaps, always to be preferred, as they poſſeſs many advantages over the other. And in every caſe they ſhould be built as near as poſſible to the farm on which the labourers who are to inhabit them are to be employed. The moſt ſuitable aſpects for the front, are the different points of the compaſs from the ſouth-eaſt round to the north-weſt. Under ſuch circumſtances as theſe, cottages, in general, need not be elevated more than one or two ſmall ſteps above the ſurface of the ground. But the ground floors of ſuch cottages ſhould not, in any inſtance whatever, be ſuffered to be lower than the ſurface of the ſituation on which they are erected, as, where the contrary is the caſe, the health of the inhabitants muſt conſtantly be in danger. The ſoil of the ſurrounding land ſhould likewiſe, if poſſible, be ſuch as that it may be advantageouſly cultivated as a garden, when converted to ſuch a purpoſe.

The ſize and internal arrangement of this ſort of building muſt of courſe be various, according to circumſtances, but in general four diviſions or rooms are ſufficient, two of which muſt be on the ground-floor, and the other two over them; the ground diviſions may occupy a ſquare of about ten or twelve feet. That into which the door opens, as it will be cold in the winter ſeaſon, may be divided and fitted up in ſuch a manner as to ſuit many convenient purpoſes in the way of ſtore-room. And by this means the common room will be kept much warmer than where the outſide door opens immediately into it*.

Where the family is large, the upper part may alſo be partitioned into a greater number of lodging-rooms, attention being always had to convenience and decency. In many caſes too, theſe points may be more fully accompliſhed by a particular arrangement of the beds; one being placed over the other, with different ways of entering into them, in the manner which we have already deſcribed, in ſpeaking of the accommodations of farming ſervants. Where this plan is adopted, the ſleeping-places ſhould always be made as eaſy of ventilation as poſſible.

As the ſcite of the farming cottage muſt of neceſſity be ſmall, it is of great conſequence to make the ſtairs and other internal parts take up as little room as poſſible. With this intention, different kinds of ſtaircaſes have been

* Young's View of the Agriculture of the County of Lincoln.

propofed, which may be feen by confulting the different plans contained in the annexed plates. In fome cafes a fort of ladder is conveniently adopted; and where two cottages are built together, room may be gained by reverfing the ftaircafes. It is, however, conceived by a writer, who feems to have attended much to the fubject, that all that is requifite in fuch buildings is "a warm, comfortable, plain room, for the poor inhabitants to eat their morfel in; an oven to bake their bread; a little receptacle for their fmall-beer and provifion; and two wholefome lodging apartments, one for the man and his wife, and another for his children. It would, perhaps, be decent, if the boys and girls could be feparated; but this would, he thinks, make the building too expenfive, and, befides, is not fo materially neceffary, as the boys find employment in farm-houfes at an early age*."

Much has been faid refpecting the forms of buildings of this defcription; but the fquare form, where no particular object is in view, though, perhaps, the moft ancient, feems to be that which affords the moft conveniences. The circular plan has, however, been lately recommended as being more cheap in its conftruction, efpecially when all formed of brick, and more eafily erected †. This is, however, obvioufly a method that does not admit of fo much convenience in the rooms, or of fheds being fo eafily erected againft the cottage on the outfide, which is frequently neceffary to be done. Befide, as they muft of neceffity ftand alone, it is doubtful whether they can be built in fo cheap a manner; and from the conical fhape of the roof, where upper rooms are made, they muft be more low and confined, and not, probably, permit the articles of furniture to be placed with fo much convenience in them.

Where expence is to be faved, it is always the beft method to build two or more cottages together, and to let them have upper as well as ground apartments. The health of the cottager and his family will, by this means, be better preferved, as it is unqueftionably more conducive to health to fleep up ftairs than on ground floors.

Attention fhould likewife be particularly paid in thefe buildings to the rendering of them warm in winter, and cool in the fummer. In this view, the walls and coverings fhould not be too thin. Where the roof is covered with tile or flate, which is by far the neateft and moft durable, though by no means fo capable of refifting the coldnefs of winter or heat of fummer as thatch, the ceilings ought to be lathed and plaftered, having flides fo conftructed as to form air-holes, by

* Kent's Hints.

† Sir John Sinclair on Cottages.

which the rooms, as well as roof, may be cooled by the free circulation of air in hot weather. If the roofs of cottages were painted, or covered over with ſome white ſubſtance which would not eaſily waſh off, it would, perhaps, tend greatly to prevent their being ſo much heated in the ſummer. Of the different ſubſtances employed for the covering of the roofs of cottages, thatch is undoubtedly the cheapeſt; and the beſt kind of thatch is, perhaps, that which is prepared from a ſtrong ſort of reed found in ſome of the midland diſtricts. I have been aſſured by a perſon of much information on the ſubject, that wheat ſtubble does excellently well for thatching cottages. He has known a coat of this material laſt thirty years without any repairing.

Where wheat-ſtraw is made uſe of, it ought to be as little bruiſed as poſſible, the corn being laſhed out, a mode which is common in moſt of the northern counties. Mr. Beatſon* ſpeaks of a well-pitched brown paper, as forming an excellent light roof; and remarks, " that, in the town of Dunfermlin, in the county of Fife, there is a church with a roof of this kind which has laſted near fifty years with very little repair, excepting a new coat of tar every ſix or ſeven years. This church is ſeventy feet long, and fifty feet wide, without any intermediate ſupport for the roof, of which the whole original expence of papering and tarring amounted only to fourteen pounds."

In regard to the materials for building cottages with, thoſe will in general be found the leaſt expenſive that are neareſt the places where they are to be erected. Stone is a very good and ſubſtantial material, and frequently much cheaper than brick; but good cottages may be built with many other ſubſtances more cheaply than with either of them; ſuch, for inſtance, as different compoſitions of well-tempered earths. Theſe, when well prepared, will ſtand a long time. Moſt of the ſtrong loamy ſorts of ſoil are found to anſwer theſe purpoſes; but where there is much ſand, clay muſt be mixed with the earth until it has the proper degree of tenacity and conſiſtence. Clay alone is not, however, ſuitable for this purpoſe, as it cannot be rammed ſufficiently hard, and is of courſe liable to crack in drying. Earthy compoſitions for this uſe ſhould always be capable of being cloſely united by means of a heavy rammer made of caſt-iron, as without this they have not ſufficient ſtability.

A cheaper method is frequently followed, which is that of forming the walls of mire and ſtraw well trodden together, and laid on in layers to the proper height; and ſometimes a footing of ſtone or brick-wall is made about two feet in height, on which is placed a cill of ſtrong timber, with upright

* Communications to the Board of Agriculture.

quarterings at the diftance of two feet, between which rounds of coarfe wood are placed croffwife at the diftance of five or fix inches from each other, until the proper height; the fpaces between the rounds are then filled with the compofition of mire and ftraw, and the whole plaftered with good mortar, which fhould afterwards be well rough-cafted over: it adds alfo confiderably to their neatnefs and general effect on the eye of the traveller, if they be well white-wafhed, a cuftom which is very prevalent in fome parts of Wales, and which is annually performed at a very trifling expence. In fome places, too, a fort of rough-ftone mafonry is employed in thefe buildings, either alone, or ftuccoed over; but this is in general a too expenfive method.

In other places another method is followed in building the walls: a ftrong earth, fuch as is proper for making bricks, is formed into walls of a fuitable height and thicknefs; after which they are left for fome time to dry, when different forts of light combuftible matters are placed round them, both on the in and out-fide, and fet on fire, by which means they are burnt into a kind of folid brick. The doors and windows are made afterwards by cutting them out of the folid walls, and the chimneys are built up with any fuitable materials. We have been informed by a very attentive obferver, that the beft walls of the earthy kind, either for cottages or other outer walls, that he has feen, have been built of the mire or earthy materials fcraped up from a turnpike or other road, after being well pulverifed by the trituration of carriages or other means.

But of whatever materials the cottage may be built, it fhould be made ftrong and well put together. If of ftone, the walls fhould not be lefs than fixteen inches thick; and when of brick, not lefs than one brick and an half. The mortar that is employed ought to be well tempered, and mixed together without an improper fparing of lime. The timber fhould likewife be well feafoned, as green timber foon decays, and, from its fhrinking, frequently produces cracks in the other materials.

The flooring for the lower rooms at leaft may either be of earth properly prepared, or they may be laid with paving tiles or bricks. The upper floors are probably the beft when laid with good boards of a ftrong and durable kind; or they may be made, as we have already obferved, of plafter, which is a good fubftance for fuch purpofes, on account of its cheapnefs, and the little danger there is of fire, as well as its being in fome degree more retentive of heat. Bricks, however, in the opinion of fome perfons who have been much engaged in the erection of buildings of this fort, fhould conftantly be recommended both for lower and upper floors as well as for the ftairs.

In conſtructing of cottages, care ſhould always be taken to ſave fuel as much as poſſible, as it is a heavy expence to the labourer to be under the neceſſity of having different fires; the heat from his common fire ſhould therefore not be ſuffered to eſcape without being applied to ſome further purpoſe in the economy of his cottage, which may often be readily done by different judicious contrivances. The upper apartments might, perhaps, be in ſome meaſure warmed by means of proper flues being placed in the vents, where they paſs through them; and by making the chimneys in theſe places themſelves as thin as poſſible, or of thin materials, and ſuch as readily tranſmit heat, as plate-iron, &c. On this ſubject Mr. Beatſon ingeniouſly obſerves, that "in all apartments kept warm by a fire, it will be found that the air at the ceiling is conſiderably warmer than the air below. If therefore," ſays he, "in a cottage that warm air is permitted to aſcend to the apartment above, it is natural to ſuppoſe it will render that apartment conſiderably warmer*." This, he thinks, may be accompliſhed either by ſliding-hatches, or by gratings, in the leaſt-frequented parts of the floor, made ſo as to open or ſhut eaſily when required. When ovens are requiſite, they ought to be ſo ſituated and contrived as that the heat which is diſſipated from them may be thrown as much as poſſible into the rooms and apartments of the cottage. When the fire is not placed on the hearth, the heat might probably be made to warm the rooms or apartments more effectually, by having the grate ſo contrived as to come conſiderably forwards in the middle, ſomewhat on the plan propoſed by the ingenious Count Rumford. Such a grate might be made at little expence, and be equally convenient for every purpoſe of the cottager. But the methods of rendering the upper rooms of cottages warm or cold, according to the particular ſeaſon of the year, and by little expence or trouble, have yet been but ſlightly attended to, though they may undoubtedly be attempted with great ſucceſs and advantage in many inſtances. A due attention to philoſophical and chemical principles might, indeed, lead the builder to numerous intereſting improvements, both in regard to the convenience and the healthineſs of dwellings of every kind.

Another circumſtance of the utmoſt importance to the cottager is, that of having near him good ſoft water; it is, therefore, of great advantage in the ſituation of cottages to be near a running ſtream of water, or where there is a ſpring of ſoft water. When it is neceſſary to collect and preſerve rain-water in covered tanks or ciſterns, the water ſhould be drawn up by means of a bucket,

* Communications to the Board of Agriculture.

or fome veffel of a fimilar kind, in order to prevent wafte. It is obferved by Mr. Holland, that "a tank, ten feet in diameter, and ten feet deep, arched over, would, at an eafy expence, fupply twenty cottages all the year round*."

Cottages, in order to render them clean and decent, fhould conftantly be provided with fmall fheds; fome parts of which may be employed as the repofitories of different forts of implements, coals, wood, &c. and others be made ufe of as a fort of pantries; but, above all, proper privies fhould be conftructed, as being not only advantageous in point of decency and cleanlinefs, but highly conducive to health, by conveying away all noxious putrid effluvia.

The expence of building cottages muft vary according to fituation, the quantity and expence of labour, the nature of, and eafe with which materials can be procured, and many other circumftances; but, in general, where no extraordinary labour or expence is required, it may be eftimated that a good brick cottage, fufficient for two families, will coft from eighty to ninety pounds; and that one of the fmaller fort for one family not lefs than fifty; if built with ftud and mud, they may, however, come confiderably cheaper, as from twenty-five to thirty pounds each.

In making calculations or eftimates for the building of cottages of this fort, attention muft, therefore, always be paid to the nature of the plan, and the materials with which they are conftructed, as well as the rates at which they can be procured; it is, however, remarked, on the authority of experience, by an intelligent writer, that in thofe parts of the kingdom even where materials and workmanfhip are the cheapeft, fuch cottages as are comfortable, healthy, and fuitable for the decent country labourer, cannot be built, if they be fingle ones, for lefs than fifty pounds, and when double, or two dwellings under one roof, for lefs than ninety pounds†, which is nearly as has been obferved above. Where inclofures of wafte or common land are made, it will, however, frequently be neceffary to build cottages on fuch plans, and of fuch forts of materials, as may render the expence of them confiderably lower than the above. This may, in fome cafes, be done by making the walls of mud, fuch as foft mire and ftraw, well incorporated together by treading with the feet, and afterwards gradually applied layer upon layer to the height which may be neceffary. This mode of building is common in the weftern diftricts, and is probably the cheapeft of any. According to Mr. Crocker, a cottage formed of this kind of

* Communications to the Board of Agriculture.

† Davis in Letters and Papers of the Bath Agricultural Society.

materials, may be erected for the trifling expence of twenty-ſeven pounds. And that where ſtones are ſcarce, others with footings of ſtone-wall for a ſtrong cill of timber to reſt upon, with upright quarterings at the diſtance of two feet, having rounds of rough wood in the manner of ladder-work, ſix or ſeven inches apart, to the proper height, the intervals between being well filled with well-wrought ſtraw and mire, or what in ſome places is termed *cab dab*, and the whole plaſtered over with good mortar, and rough caſted, may be conſtructed for fifty-eight pounds*.

Mr. Kent has given different uſeful plans and eſtimates for the building of cottages of various kinds; but when erected in the cheapeſt method, which, as has been already obſerved, is that of two of them being built together, ſtand higher than the above.

BRICK COTTAGES.

For two cottages of this kind, of the ſmalleſt ſize, his eſtimate is this:—

Bricklayers' Work.

	£.	s.	d.
The walls 166 ſquare, at 4*s.* 6*d.* per ſquare -	37	7	0
Pan-tiling, with ſmall-ſized deal lath, and ſparkled within ſide, ten ſquare and a half, at 1*s.* 2*d.* per ſquare -	11	11	0
Partitions lathed and plaſtered, on each ſide, with two coats of mortar, 107 yards, at 10*d.* per yard - -	4	9	0
Plaſtering the walls, 144 yards, at 6*d.* per yard -	3	12	0
Paving with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8
Ceiling, between the joiſts, 125 yards, at 6*d.* per yard	3	2	6
Two ground-floor chimneys, and two fire-places in the chambers, and two ovens and oven-lids - -	9	2	0
Foot-lacing in the chambers - - -	1	1	0
Two flag-ſtones, for the chamber chimneys - -	0	4	0

Carried forward - £.78 15 2

* Communications to the Board of Agriculture, vol. I.

	£. s. d.	£. s. d.
Brought over -		78 15 2

Glaziers' Work.

	£. s. d.	
Sixty-nine feet of glaſs, at 8*d.* per foot - -	2 6 0	
Flaſhings of lead for the roof-windows - -	0 10 0	
		2 16 0

Smiths' Work.

Two large caſements, at 6*s.* 6*d.* each - -	0 13 0	
Four ſmall ditto, at 4*s.* each - - -	0 16 0	
Chimney-irons to hang pots on - - -	0 7 6	
Two ſtoves for chamber fire-places - -	0 13 0	
		2 9 6

Carpenters' Work.

Four tons of pollard timber, at 1*l.* per ton -	4 0 0	
Five tons of deal timber, at 2*l.* 5*s.* per ton -	11 5 0	
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare	4 4 6	
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare	2 8 0	
Six ſquare of flooring, with white-wood deal, at 18*s.* per ſquare	5 8 0	
Twelve pair of door-caſes, at 2*s.* a pair - -	1 4 0	
Twelve doors, at 4*s.* each - - -	2 8 0	
Eight windows, at 2*s.* 6*d.* each - -	1 0 0	
Two winding ſtaircaſes, at 1*l.* 5*s.* each -	2 10 0	
Five ſquare of ſtud-partitions, at 6*s.* 6*d.* per ſquare -	1 12 6	
Two pieces of timber to lay on the chimneys -	0 2 0	
Two roof-windows, at 6*s.* each - -	0 12 0	
Nails, and irons, for doors - - -	1 12 0	
Eight window-boards, at 1*s.* each - -	0 8 0	
Shelves and work to pantries - - -	0 12 0	
Carriage of materials, eſtimated at - -	8 0 0	
Add, to make the calculation even - -	0 13 4	
		47 19 4

The amount of the two cottages -	£.132 0 0
The amount of one - - -	£. 66 0 0

STUD-WORK COTTAGES.

For two cottages of this ſort, of the ſmalleſt ſize, with brick gables, it is as follows:—

Carpenters' Work.

	£.	s.	d.			
Four tons of pollard timber, at 1*l.* per ton -	4	0	0			
Five tons of deal timber, at 2*l.* 5*s.* per ton -	11	5	0			
Eight ſquare and fifty feet of ſtud-work, on the ſides, at 10*s.* per ſquare - - - -	4	5	0			
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare	4	4	6			
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare	2	8	0			
Six ſquare of flooring, with white-wood deals, at 18*s.*	5	8	0			
Twelve pair of door-caſes, at 2*s.* a-pair - -	1	4	0			
Twelve doors, at 4*s.* each - - -	2	8	0			
Eight windows, at 2*s.* 6*d.* each - -	1	0	0			
Two pair of ſtairs, at 1*l.* 5*s.* each - -	2	10	0			
Five ſquare of ſtud-partitions, at 6*s.* 6*d.* per ſquare -	1	12	6			
Two pieces of timber to lay on the chimneys -	0	2	0			
Two roof-windows, at 6*s.* each - -	0	12	0			
Nails, and irons, for the doors - -	1	12	0			
Eight window-boards, and ſhelves and work to pantries	1	0	0			
				43	11	0

Smiths' Work.

	£.	s.	d.			
Two large caſements, at 6*s.* 6*d.* each - -	0	13	0			
Four ſmall ditto, at 4*s.* each - - -	0	16	0			
Four chimney-irons to hang pots on - -	0	7	6			
Two ſtoves for chamber fire-places - -	0	13	0			
				2	9	6

Glaziers' Work.

	£.	s.	d.			
Sixty-nine feet of glaſs, at 8*d.* per foot - -	2	6	0			
Flaſhings of lead for the roof-windows - -	0	10	0			
				2	16	0

Carried forward £. 48 16 6

	£.	s.	d.	£.	s.	d.
Brought over -				48	16	6

Bricklayers' Work.

	£.	s.	d.	£.	s.	d.
Forty-four yards of 14-inch wall, at 4*s.* 6*d.* per yard	9	18	0			
Two flag-ſtones for the chamber chimneys -	0	4	0			
Two ground-floor chimneys, and two fire-places in the chambers, and two ovens and oven-lids - -	9	2	0			
Outſide lathing and plaſtering, 94 yards, at 1*s.* per yard	4	14	0			
Twenty-five yards of foundation, nine inches, at 3*s.*	3	15	0			
Pan-tiling, with ſmall-ſized deal lath, and ſparkled withinſide, ten ſquare and an half, at 1*l.* 2*s.* per ſquare -	11	11	0			
Partitions lathed and plaſtered on each ſide, with two coats of mortar, 107 yards, at 10*d.* per yard -	4	9	2			
Ceiling between the joiſts, 125 yards, at 6*d.* per yard -	3	2	6			
Lathing and plaſtering the inſide of the ſtuds, 144 yards, at 6*d.* per yard - - - -	3	12	0			
Paving with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8			
Carriage of materials, eſtimated at - -	8	0	0			
Add, to make the calculation even - -	0	9	2			
				67	3	6
Amount of theſe two cottages - - -				£.116	0	0
Amount of one cottage - - -				£. 58	0	0

In erecting the larger kind of cottages where bricks are employed, ſavings of ſuch expenſive materials may be made by having the ends hipped in, and at the ſame time no more tiling will be neceſſary. And beſides, in this method, the buildings are more firmly braced together, and, conſequently, more ſecure from the effects of high winds*.

* Kent's Hints, p. 220.

FARM COTTAGES.

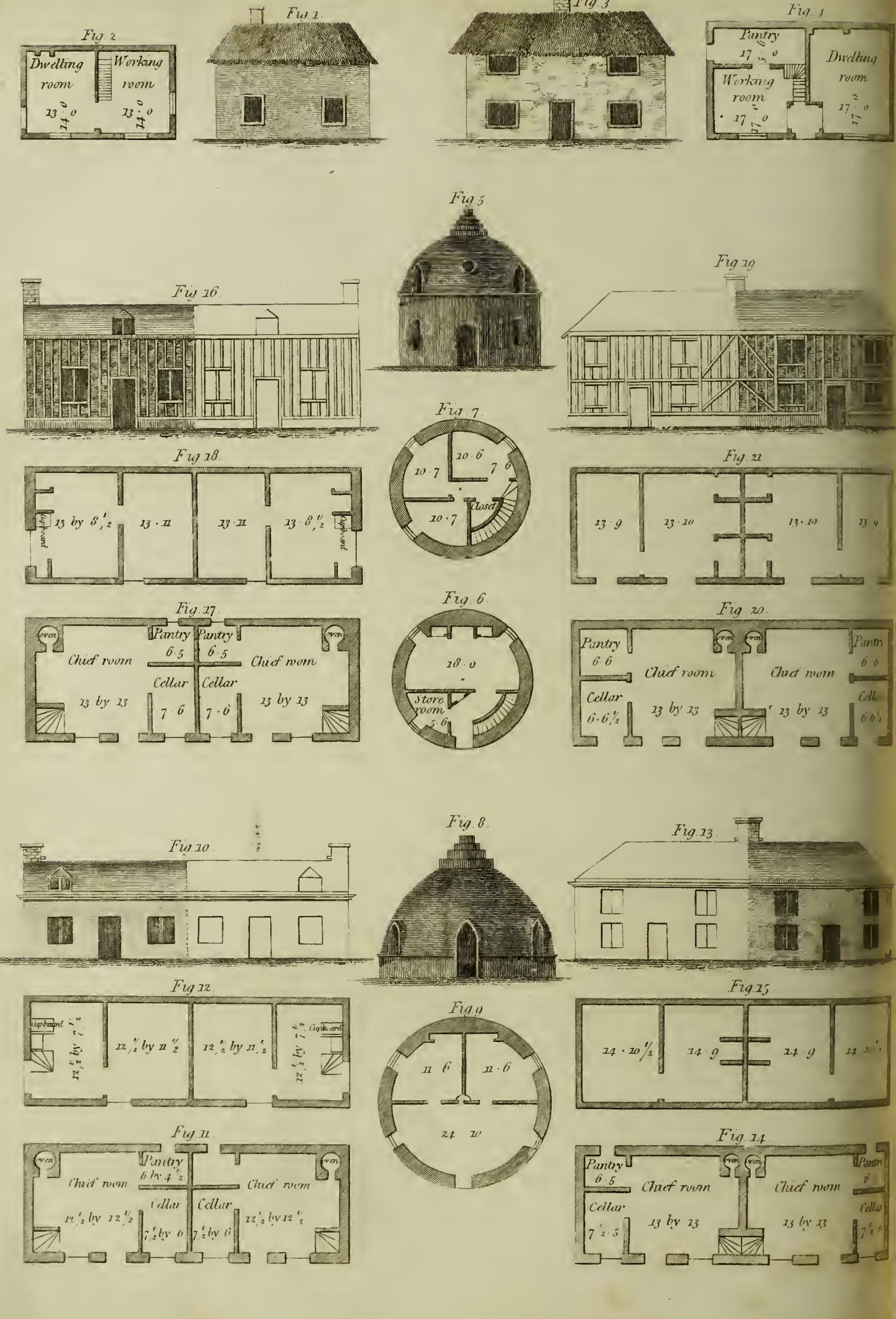


PLATE XXVIII.

Farm Cottages.

[*To face Page* 92.]

AT *Fig.* 1. is reprefented a fmall *mud-walled* cheap cottage, the chambers being lighted from the ends

Fig. 2. Is the ground plan of it.

Fig. 3. Exhibits a cheap fort of cottage on a larger plan, built of *cub dab.*

Fig. 4. Is the ground plan of it. Thefe are the cheapeft forts of cottages that can be built, and are from plans of Mr. Crocker.

Fig. 5. Reprefents a circular cottage, recommended by Sir John Sinclair.

Fig. 6. Is the ground plan of it ; and *Fig.* 7. The fecond floor.

Fig. 8. Is another cottage of the fame fort, but without any fecond floor. *Fig.* 9. Is the ground plan or floor. Thefe are capable of being built wholly of brick at a fmall expenfe.

Fig. 10. Exhibits the plan and elevation of two small-fized bricked cottages.

Fig. 11. Shows the ground plan or floor : and, *Fig.* 12. The chamber floor.

Fig 13. Is the plan and elevation of two cottages of the fame fort, but of a larger fize and with hipped ends.

Fig. 14. The ground plan or floor : and *Fig.* 15. The floor above.

Fig. 16. Is the plan and elevation of two *ftud-work cottages*, with brick gable ends.

Fig. 17. Is the ground floor : and *Fig.* 18. The floor above.

Fig. 19. Reprefents the plan and elevation of two cottages of the fame kind, but of a larger fize and with hipped ends.

Fig. 20. Is the ground floor : and *Fig.* 21. The chamber floor.

Thefe cottages are recommended by Mr. Kent, as being capable of being built at a moderate expenfe, and as convenient and well adapted to farm purpofes.

2

BRICK COTTAGES WITH HIPPED ENDS.

For two cottages of this sort of the largest size :—

Bricklayers' Work.

	£.	s.	d.			
The walls, 181 yards, at 4*s.* 6*d.* per yard - -	40	14	6			
Pan-tiling, with small-sized deal lath, eleven square, at 1*l.* 2*s.* per square - - - -	12	2	0			
Double stack of chimneys, and two fire-places in the chambers, and two ovens and oven lids - -	10	2	0			
Two flag-stones for the chamber chimneys -	0	4	0			
Paving, with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8			
Partitions lathed and plastered, on each side, at 10*d.* per yard	3	15	0			
Ceiling, between the joists, 125 yards, at 6*d.* per yard -	3	2	6			
False ceiling, in the chambers, under the joists, two coats, 130 yards, at 1*s.* per yard - - -	6	10	0			
Plastering the walls, 169 yards, at 6*d.* per yard -	4	4	0			
				89	0	8

Glaziers' Work.

Ninety-feet of glass, at 8*d.* per foot - -	3	0	0			
				3	0	0

Smiths' Work.

Four large casements, at 6*s.* 6*d.* each - -	1	6	0			
Two small ditto, at 4*s.* each - - -	0	8	0			
Two stoves for chamber fire-places - -	0	13	0			
Chimney irons to hang pots on - -	0	7	6			
				2	14	6

Carpenters' Work.

Three tons of pollard timber, at 1*l.* per ton -	3	0	0			
Three tons and an half of deal timber, at 2*l.* 5*s.* per ton	7	17	6			
	10	17	6			
Carried forward -				£.94	15	2

	£. s. d.	£. s. d.
Brought over		94 15 2
	10 17 6	
Nine ſquare and forty feet of roofing, at 9*s*. per ſquare	4 4 6	
Five ſquare of ſtudded partitions, at 6*s*. 6*d*. - -	1 12 6	
Six ſquare and an half of flooring joiſts, at 7*s*. 6*d*. per ſquare	2 8 0	
Six ſquare of flooring, with white-wood deals, at 18*s*.	5 8 0	
Twelve pair of door-caſes, at 2*s*. a pair - -	1 4 0	
Two pieces of timber to lay on the chimneys -	0 2 0	
Twelve doors, at 4*s*. each - -	2 8 0	
Eight windows, at 2*s*. 6*d*. each - -	1 0 0	
Two pair of ſtairs, at 1*l*. 5*s*. - -	2 10 0	
Nails, and irons, for the doors - -	1 12 0	
Two pieces of timber, the whole length of the building, for lintels, to lay the joiſts on - - -	0 6 0	
Six ſquare and an half of ceiling joiſts, at 6*s*. 6*d*. per ſquare	2 2 3	
Eight window-boards, at 1*s*. each - -	0 8 0	
Shelves and work to pantries - -	0 12 0	
Carriage, eſtimated at - - -	8 0 0	
Add, to make the calculation even - -	0 10 1	
		45 4 10
Amount of the two cottages . - -		£.140 0 0
Amount of one - - -		£. 70 0 0

STUD-WORK COTTAGES WITH HIPPED ENDS.

For two ſtud-work cottages, with hipped ends:—

Carpenters' Work.

	£. s. d.
Five tons of pollard timber, at 1*l*. per ton -	5 0 0
Six tons of deal timber, at 2*l*. 5*s*. per ton -	13 10 0
Sixteen ſquare and ſixteen feet of ſtud-work, on the ſides, at 12*s*. per ſquare - - - -	9 13 6
Five ſquare of ſtud-partitions, at 6*s*. 6*d*. per ſquare -	1 12 6
Carried forward -	29 16 0

	£.	s.	d.			
Brought up -	29	16	0			
Six ſquare and an half of flooring joiſts, at 7*s*. 6*d*. per ſquare	2	8	0			
Six ſquare and an half of ceiling joiſts, at 6*s*. 6*d*. per ſquare	2	2	3			
Nine ſquare and forty feet of roofing, at 9*s*. per ſquare	4	4	6			
Six ſquare of flooring, with white-wood deals, at 18*s*. -	5	8	0			
Twelve pair of door-caſes, at 2*s*. a pair - -	1	4	0			
Twelve doors, at 4*s*. each - - -	2	8	0			
Eight windows, at 2*s*. each - - -	0	16	0			
Two pair of ſtairs, at 1*l*. 5*s*. each - -	2	10	0			
Shelves and work to pantries - -	0	12	0			
Two pieces of timber to lay on the chimneys -	0	2	0			
Eight window-boards - - -	0	8	0			
Nails, and irons, for the doors - -	2	0	0			
				53	18	9

Smiths' Work.

	£.	s.	d.			
Four large caſements, at 6*s*. 6*d*. each -	1	6	0			
Two ſmall ditto, at 4*s*. each - -	0	8	0			
Two ſtoves for chamber fire-places - -	0	13	0			
Four chimney-irons to hang pots on - -	0	7	6			
				2	14	6

Glaziers' Work.

	£.	s.	d.			
Ninety feet of glaſs, at 8*d*. per foot - -	3	0	0			
				3	0	0

Bricklayers' Work.

	£.	s.	d.			
Falſe ceiling, in the chambers, under the joiſts, 130 yards, at 1*s*.	6	10	0			
Ceiling between the joiſts, 125 yards, at 6*d*. -	3	2	6			
Forty-four yards of foundation-walls, at 3*s*. per yard -	6	12	0			
Outſide lathing and plaſtering, 122 yards, at 1*s*. per yard.	6	2	0			
Ten ſquare and an half of tiling, at 1*l*. 2*s*. per ſquare -	11	11	0			
Inſide partitions lathed and plaſtered, on both ſides -	3	15	0			
Two ground-floor chimneys, and two fire-places, and two ovens and oven-lids. - - -	10	2	0			
	47	14	6			
Carried forward -				59	13	3

		£. s. d.
Brought over -		59 13 3
	£. s. d.	
	47 14 6	
Paving, with white bricks, 125 yards, at 1*s*. 4*d*. -	8 6 8	
Lathing and plaftering the infide-ftuds, two coats of mortar, 169 yards, at 1*s*. per yard - -	8 9 0	
Two flag-ftones for chamber fire-places - -	0 4 0	
Carriage of materials, eftimated at - -	8 0 0	
Add, to make the calculation even - -	0 12 7	
		73 6 9
Amount of thefe two cottages - -		£. 133 0 0
Amount of one - - -		£. 66 10 0

In the letting or management of cottages, there are feveral circumftances that require to be more attended to than feems in general to have been the cafe. It fhould always be the object of the proprietors of farms to guard the labouring cottager, as much as poffible, from being injured by any improper conduct in the common farmer, while at the fame time his labour is effectually fecured to the farm; and alfo, that his little rent be exacted in the moft eafy and convenient way. The firft may, probably, be the moft eafily effected by the proprietors of lands keeping the cottages that may be upon their farms in their own hands, and not fuffering their tenants to have the direction or management of them; and by their having juft and equitable ftipulations in refpect to labour entered into between their cottagers and their tenants. The latter may be acco plifhed in various ways; but that which is practifed in fome of the midland diftricts, of deducting from their wages, at the clofe of every week, a fmall part proportioned to the value of their labour, and the annual fum which they pay for their cottage, in order to difcharge their rent, feems the leaft objectionable. It is obferved by an ufeful and well-informed writer on the fubject, that " there is another plan relative to cottages, which generally anfwers extremely well, and that is, to leafe them off to induftrious labourers, for the term of three lives, at their nomination; taking a very moderate fine, not exceeding ten or twelve pounds, upon a cottage worth about forty fhillings a-year; referving a fmall quit-rent, not exceeding half a crown a-year, and making it a point to renew any life which drops off, upon one year's value only." This fcheme, he contends, is beneficial for landlord and tenant; for though the former does not let his

cottages for ſo much as he might at rack-rent, yet what he does get, is all clear money; and by this means he preſerves the value of all other parts of his eſtate, by keeping up a proper number of inhabitants. The latter, he thinks, finds his account in it, becauſe he makes a ſettlement for his family; and can repair and improve his cottage at leiſure hours with his own hands; and if he be an induſtrious man, he can generally find a friend to lend him his firſt fine, on ſuch an occaſion, if he cannot raiſe it himſelf*.

This is a plan that has been attempted with ſucceſs in different diſtricts; but it is, perhaps, better calculated for the large than the ſmall proprietor.

From what has been advanced, it muſt be ſufficiently evident that the building of proper cottages for farming labourers is not merely a matter that intereſts the proprietors of land, inſomuch as it renders the ſituation of that uſeful claſs of workmen more comfortable, but which, at the ſame time, has a great tendency to promote the full and complete cultivation of the ſoil.

* Kent's Hints, p. 217.

SECTION IV.

Inclosing of Land.

INCLOSING.—Advantages of, various—Contributes much to Improvements in Cultivation—Produce thereby greatly augmented—Utility of, in producing Warmth and Shelter—Promotes the Fattening of Animals—Value of Land much increased by it—Some Sorts more than others—Turnip Soils probably the most—Where necessary or not—Has not been sufficiently attended to—Causes of this Neglect—Sometimes arises from Mismanagement in the Direction of Inclosures—Various Circumstances to be regarded in—Utility of certain Clauses in Bills of Inclosure—Building Cottages necessary—Situation of thus improved—Methods of appointing Persons to transact the Business of Inclosure—Circumstances to be attended to in—Utility of a general Act of.—FENCES—Circumstances to be regarded in the Making of—Particulars to be attended to in—Should be regulated by the Kind of Farm and Nature of Soil—Effects of different-sized Inclosures—Middle-sized generally most advantageous—Difference of in Grass and Arable Land—Circumstances to be attended to in each—Advantages of different Kinds.—WALLS—Different Kinds of, described—Advantages of each—Nature of Foundations of—Modes of making of—List Walls—Dry Walls—Earth and Stone Walls, or Dikes—Method of forming them, according to Dr. Anderson—Means of protecting them—May be made cheaply—Rendered more lasting by dashing, lipping, and hurling with Lime—Middleton's Opinion of Walls in general—In some Situations most advantageous for a limited Time.—PAILING-FENCES—Cannot be generally adopted for Farm Inclosures—Different Kinds of, described—May often be cheaply made—Utility of, in particular Cases—Hurdles or moveable Fences—Should be formed of light Wood—Circumstances to be regarded in erecting Pailing-Fences—Means of preserving them from Decay.—LIVE HEDGES—Attention to Situation and Soil necessary in raising—Kind of Ground and Situation in which different Sorts of Plants may be most usefully employed—Different Advantages of the White and Black Thorn—The Willow-Alder, Furz, and Beech—Circumstances to be regarded in using a Mixture of different Sorts of Plants—Necessary Preparation of the Land, and the Advantages of it—Proper Season of planting—What necessary to attend to in choosing the Plants—In raising them in the Nursery—Most advantageous Size of—Those of equal Growth should be planted together—The trimming requisite for them—Methods of planting Hedges—Vary much in different Districts—On ditch Banks—On Sod turned up—On the plain Surface—Different Ways of making them—Advantages and Disadvantages of each Mode—Methods recommended by Mr. Middleton—Utility of them—What necessary in planting on Banks—Disadvantage of large

Banks and Ditches—Where moft ufeful—Planting on the Surface without Banks—Where proper—Means of fheltering young Hedges—Circumftances that prevent quick Hedges from fucceeding—Difadvantages of Trees in Hedge-rows—Modes of managing young live Hedges—Comparifon of, with Walls—Management of old Hedges—In different Situations—When expofed to fea Air.—DITCHES—What neceffary in the making of them.—GATES—Various Modes of Conftruction of—Kinds of Wood moft ufeful---What neceffary to be attended to in.—STILES—Beft Methods of making them---Obfervations on Fences in general---On the Means of making, managing, and preferving them.

THE beneficial confequences that neceffarily refult from the inclofure of land, whether in a ftate of wafte and common, or otherwife, are numerous and important. In addition to thofe of afcertaining and fecuring the property, it holds out, not only the moft ready and certain means of improvement in the cultivation of the former, but in fuch as have been long under the plough, or any other fyftem of management; being equally ufeful in its tendency to bring them into the moft perfect and advantageous ftates of culture. Without inclofing, however, much attention may have been paid, or expence incurred, in carrying on the various proceffes that are requifite in preparing land for the reception and growth of good crops; whether of the grain, root, or grafs kinds, it is obvious that they can neither be conducted under the moft beneficial management, nor yield the full advantage they are capable of, while they continue in a free and open ftate. Where the land is in a ftate of arable cultivation, without inclofure, the crops, of whatever fort they may be, muft conftantly be expofed to depredations of various kinds; and if in the ftate of grafs or pafture, injuries of the moft prejudicial nature muft frequently be unavoidably fuftained. The great advantage and importance of inclofing land is ftill more fully demonftrated in the differences which may be obferved, in refpect to the quantity and value of the produce, in fuch as have been thus divided, over that which is cultivated in the ftate of open or common field.

It is well obferved, by an intelligent practical writer, that " in proportion as a field or a country is bleak, naked, and expofed to chilling blafts and winter ftorms, in the fame proportion will it be unproductive, compared with lands more favourably fituated. Inclofing is a mean of obtaining, by art, a certain degree of that genial warmth fo effential to the production of valuable crops, but which nature is not always pleafed to beftow. Every day's experience," continues he, " proves that where grounds are fheltered from the violence of ftorms, as by garden-walls, or by plantations of foreft-trees, they are more pro-

ductive, and vegetation is earlier than in others fimilar in every refpect, unlefs in regard to expofure. How many inftances," fays he, " occur to eftablifh this fact, in refpect to large fields, as well as to gardens, orchards, &c. Let the obfervant farmer, who poffeffes an inclofed farm, examine that part of a field where, owing to the decay of the fence, the wind enjoys a free paffage, and he will be fatisfied of the benefit of inclofing, from the fuperiority of the crop in the other part of the field, over that which is within the influence of this additional expofure. While, on the other hand, the poffeffor of an open field farm, by examining the fuperior verdure that takes place in any part of an open field, that is by fome accidental circumftances fheltered in a remarkable degree, may fatisfy himfelf, that were the whole equally fheltered, the produce would be more abundant*."

And by another author, it is remarked, that " as the warmeft air lies neareft the furface of the earth, being that portion of the atmofphere which, like a blanket, nature fpreads over the foil and its productions, fences of all kinds tend more or lefs to prevent fuch a valuable covering from being blown off by the winds†."

But, befides thefe, there are other benefits to be derived from the judicious fencing in, or inclofing of land, proceeding from the warmth and fhelter which it affords to cattle of various kinds. Under thefe circumftances, animals are invariably found not only to advance in flefh much more rapidly, but to be freer from diforders, than when kept in fituations that are bleak and expofed, and which cannot afford warmth or fhelter to them. " If," fays the author we have firft quoted, " any perfon entertain doubts refpecting the inclofed paftures being better adapted for rearing and fattening live-ftock than open fields, he may eafily fatisfy himfelf, by comparing the live-ftock in an inclofed parifh with that of one in the open-field ftate. He is much miftaken," he fays, " if he will not find them, in the latter, not only fewer in number, but each animal, on an average, thirty or forty per cent. inferior in value. In fhort, inclofing," he thinks, " may be denominated the firft ftep towards effecting improvements in the breeds of the different fpecies of live-ftock. And on the whole, this," he conceives, " is reafoning on plain eftablifhed facts, and on fuch as afford the moft indubitable evidence of the fuperiority of inclofed fields, whether for tillage or pafturage. Were farther proof neceffary, the additional rent which is every-where paid for

* Donaldfon's Modern Agriculture, vol. III. p. 302.

† Robertfon's Prefent State of Agriculture in Mid-Lothian, fecond edition, p. 77. Note.

inclofed land, beyond that paid for land of an equal quality in the open field ftate, is fufficient," he thinks, " to place the matter beyond all poffibility of doubt."

By means of inclofing, the value of the land is, in moft fituations, confiderably improved. The proportion of the increafe of value that may be made in this way, whether the inclofed lands be in a ftate of leafe, or in the hands of the proprietor, muft, however, depend greatly on the nature of the foil, and the fyftem of management that is purfued. It is obferved, that " lands of a middling quality, good turnip foil for inftance, are probably benefited to a greater degree by inclofing, than thofe of fuperior or inferior quality. Lands of this defcription, in the open-field ftate, may, it is afferted, be confidered as rented to the full at fifteen fhillings the acre; whereas there are few inftances where fuch lands, when inclofed, are rented under twenty fhillings; an advance fo great as to afford the proprietor a handfome profit, after paying the intereft of the money expended. Thus does inclofing not only increafe the quantity and quality of the produce, fo as to enable the farmer to pay his landlord a higher rent, and to contribute a larger fhare to the revenues of the ftate, but from fo many people being conftantly employed in making and repairing the fences, inclofing, in this view, muft alfo be confidered as beneficial *."

There are, however, in many diftricts, extenfive, barren, and mountainous tracts of land, that can never be inclofed with the leaft profpect of advantage; or, if they could, that could never derive any amelioration from fuch a meafure; the only means by which they can be improved is by being rendered, in particular fituations, more free from injurious furface moifture, by proper drainage, or by the introduction of better and more perfect breeds of the feveral kinds of animals, which it may be neceffary to turn upon them. In fome other fituations too, as where the land is capable of being cultivated almoft conftantly under the arable fyftem, inclofing, at leaft with any kind of high fences, may be, in a great meafure, if not wholly, unneceffary. But, in general, where lands are cultivated under a fyftem of management, fuch as that of alternating grafs or other kinds of green crops with thofe of grain, and thereby combining improvement in the breed of live-ftock with that of arable cultivation, the practice of inclofing muft always be neceffary and advantageous.

But, notwithftanding the advantages that, in various points of view, thus evidently refult from the inclofing of land, the practice is far from having been fo much encouraged or attended to, as its utility and importance would feem to demand.

* Donaldfon's Modern Agriculture, vol. III. p. 305.

This may have proceeded partly from the difficulty that muft neceffarily attend the bufinefs in every cafe, and, efpecially in wafte or common-field lands, from the diverfity of claims, and partly from the improper conduct or mifmanagement of thofe who have the direction of it.

It may, therefore, not be improper to take notice of fome of the leading circumftances that ought to be regarded in directing the means of fuch inclofures.

In the inclofing of waftes and commons, much oppofition and delay often proceeds from the caufes juft mentioned, as well as from a neglect of, or inattention to, proper accommodation in the fmall allotments, fuch as thofe of cottagers, and other labourers who have claims.

In the management of inclofures it is, therefore, neceffary that due attention fhould be had to the rights and interefts of cottagers, and the labouring claffes, who have fmall claims, as well as thofe of the larger proprietors. Mr. Bellingfley, in his able report of the Agriculture of the County of Somerfet, has, indeed, obferved, that whether the inclofing of commons be accomplifhed "by the unanimous confent of the parties claiming rights, who delegate power to commiffioners, chofen by themfelves, to afcertain their validity, and divide accordingly under covenants and agreements, properly drawn and executed for the purpofe, or by act of parliament obtained by the petition of a certain proportion of the commoners; it is manifeft that the rights of the cottager cannot be invaded, fince, with refpect to legal or equitable conftruction, he ftands precifely on the fame ground with his more opulent neighbours." And in regard to his intereft, he remarks, that, in all the cafes that have fallen under his obfervation, "inclofures have ameliorated his condition by exciting a fpirit of activity and induftry, whereby habits of floth have been by degrees overcome, and fupinenefs and inactivity have been exchanged for vigour and exertion." The reduction of the poor-rates in many of thofe parifhes where inclofing has been practifed, is, he thinks, a ftrong proof of the truth of the pofition.

In conducting the bufinefs of an inclofure, it would feem to be the moft proper method for the commiffioners, after afcertaining the nature and quantity of land, and marking out the neceffary roads, bridges, &c. in the moft eafy and convenient directions, to apportion out the allotments of the fmalleft proprietors firft, without the leaft diftinction of perfons, fo as to render fuch allotments as fuitable and convenient as poffible for thofe who are to occupy them; as it is fufficiently obvious that the fmall claimant might as well have no allotment at all, as to have it at fuch a diftance from his dwelling as to be managed with great

inconvenience and difadvantage, or in a way that muft prevent him from going to, and performing his daily labour; under fuch circumftances he would moft probably have no alternative but that of difpofing of his little property, which might otherwife be of great utility to him, to his more opulent neighbour. From fuch fmall claimants they fhould progreffively advance to the largeft proprietors, having conftantly an eye to the accommodation and convenience of each, but without permitting any injury to be done thereby to another. This is unqueftionably a very difficult, as well as troublefome part of the bufinefs; but by proper attention, a complete knowledge of the fubject, and proper management, much may be fatisfactorily accomplifhed.

In cafe of the town being fituated near to, or in the middle of, the inclofure, the allotments of the different proprietors may often very properly be laid out in fuch a way as to join, or nearly join, to the farm houfes; and they fhould likewife be as much in fquares as their nature will admit of; but where the cafe is the contrary, the allotments at a diftance ought to be fo diftributed, as to render them moft advantageous for occupation as farms, on which houfes and proper offices may be built, regard being always had to the convenience of water, and to different forts of land, as well as many other points of conftant importance to the farmer.

It would probably, too, be a meafure of found policy, as well in a national as other points of view, to have a provifion in bills of inclofure, for the building of a certain number of cottages, proportionate to the extent of the inclofed common or wafte, with a fmall allotment of land annexed to each, at leaft as much as is fufficient for a garden, which, in general, need not exceed a rood. Thefe cottages fhould be folely deftined for the ufe and advantage of fuch poor labouring perfons as belong to the parifh. Such a regulation as this would probably be attended with many good confequences; it would render the bufinefs of inclofing lefs objectionable to the labouring cottager, promote the cultivation of land, and at the fame time have a tendency to leffen the expences of the poor. For it is a curious and important fact, that in moft parifhes where no inclofures of wafte lands have been made, the rates for the fupport of the poor have been increafed to an aftonifhing degree*. In fome inftances, even in a treble and quadruple proportion.

It is well obferved by a noble writer, who we have had occafion to quote before†, that " upon an inclofure, if the owners choofe it, the labourers who

* Billingfley's View of the Agriculture of the County of Somerfet.

† Earl of Winchelfea in Communications to the Board of Agriculture, vol. I.

keep cows may be placed in a much better fituation than they were, inafmuch as inclofed land is more valuable to occupiers of every defcription, than commons and open fields. Garden ground may alfo be allotted to them, as well as others, which cannot be done while the land remains uninclofed." He is perfuaded that " where thefe things are attended to, very few objections to an inclofure will arife on the part of the labourers, and that the land owners will have the fatisfaction of benefiting the poor, and at the fame time of making their own property more valuable, by adopting what, in all probability, will be the means of keeping down the poor-rates."

Wherever the fyftem of inclofing is adopted, much care and circumfpection is neceffary, in order to guard againft expence, in the appointment of perfons for the conducting and managing of the bufinefs. None but fuch as are known to be fully capable fhould be fixed upon, either as folicitors for promoting and procuring the act of parliament, when neceffary, or commiffioners for tranfacting and arranging the bufinefs of the inclofure. After fuch act has been obtained, it is a matter of great confequence in appointing the latter, to have them from the vicinity of the inclofure, that they may be acquainted not only with the different local circumftances and peculiarities of the place, but the nature of the foils, and the beft means of their being improved. Some of them too fhould always be perfons who have a perfect knowledge of the forms and modes of conducting the bufinefs, and a practical acquaintance with accounts, and the prices of making all forts of fences, gates, roads, bridges, drains, &c. as well as fufficient information both of the theory and practice of agriculture itfelf; much of thefe various forts of knowledge being conftantly required in the conducting of an inclofure.

Where perfons are thus qualified, and without it errors and miftakes muft be continually committed, two, or at moft three commiffioners, will generally be fully adequate to the execution of the bufinefs, even in the moft extenfive inclofures. And in many cafes where the wafte land to be inclofed is fmall in quantity, one intelligent commiffioner may be fufficient for the purpofe.

Where country folicitors are employed, they may act as clerks to the commiffioners, by which a confiderable faving of expence may often be made; or this may, in moft cafes, be accomplifhed by the commiffioners entering their own minutes and orders, which, in general, is attended with but little trouble. The office of furveyor, as being, in general, expenfive, fhould be cautioufly difpofed of. The beft mode is probably that of fixing an adequate fum for the tranfaction of the whole of the bufinefs that may be requifite, after the act has been procured; care being taken that the perfon who engages be duly qualified, and of eftablifhed cha-

racter, for the office. Such a plan would not only fave much trouble, but, in different inftances, confiderable expence to the proprietors.

Another circumftance which ought to be particularly regarded in the inclofing of commons, is that of no greater delay being permitted in giving the different proprietors poffeffion of their allotments, than is abfolutely requifite. If thefe feveral points were fufficiently attended to, there would probably be very little reafonable objection made to the fyftem of inclofing; as thofe which have been advanced, on the grounds of injuries done to the breeding of cattle, the expences of farming buildings, the deterioration of the quality of wool, or the diminution of its produce, by a reduction in the number of fheep, and the leffening of the rental value of fuch eftates as are in the neighbourhood of inclofed commons, are, when fully examined, too feeble and unfatisfactory to deferve much regard*.

It is forcibly obferved by the able writer of one of the county reports on agriculture, that, " when the inclofing fyftem is appreciated, by its obvious tendency to increafe the produce of land, and the demand for labour, to augment the rate of wages to the hufbandman, and to leffen the amount of the poor-rate; it is a fubject of regret and aftonifhment, that fo few means have been devifed by the legiflature, either to facilitate or extend its progrefs. How much is to be done this way," fays he, " a general inclofure act, unfettered by tedious and expenfive formalities, would fpeedily manifeft. From the very great number of private acts which have paffed within the laft twenty years, fuch general principles might," he fuppofes, " be felected for its bafis, as to implicate almoft every poffible variety of claim, intereft, and property. An act thus conftituted," he thinks, " might, without hazard or injury, be entrufted to a given number of juftices at the quarter feffions, to difpenfe its powers, and control its execution; and fuch juftices," he conceives, " perfectly competent to determine on the propriety or impropriety of any propofed inclofure. Thus," continues he, " a total extinction of parliamentary expence would encourage inclofing on the fmalleft fcale; and, with advantages not to be defpifed, would accommodate the moft extenfive†."

That fuch a meafure is calculated to promote the advantage of individuals, as well as that of the nation, cannot be much doubted by thofe who have at all confidered the nature of the fubject. We therefore hope that a general act of inclofure may, at no very diftant period, be obtained, notwithftanding the inju-

* See the obfervations of Mr. Bellingfley on thefe points in his Report, p. 53.

† Billingfley's View of the Agriculture of the County of Somerfet.

P

dicious, illiberal, and very inconſiderate oppoſition it has hitherto experienced, by which thoſe numerous commons and waſte lands, that have ſo long remained in a barren and unproductive ſtate, to the diſgrace of the country, and the reproach of agriculture, may be put under a ſyſtem of cultivation and improvement.

The benefits which would be derived from the general incloſure of commons would no doubt be various. In addition to the increaſe in the value of ſuch lands to the owners, which, as has been obſerved, would be conſiderable in many places, eſpecially near large towns *; in regard to the public, it would be of ſtill more extenſive utility. It would, likewiſe, be the means of raiſing and ſupporting a more numerous, as well as a much better breed of neat cattle and ſheep, and of preventing the latter from being attacked and de-

* The increaſe in the value of waſte land, which may be effected by this means, and that of proper drainage, is fully ſhewn in the following uſeful Table, drawn up by Mr. Parkinſon of Aſgerby, ſteward to Sir Joſeph Banks, and inſerted by Mr. Young in his View of the Agriculture of the County of Lincoln.

Statement of Improvements.

Pariſhes.				Improved value.			Old value.			Improvement.			Expenditure.			Intereſt at 5 per cent.	Net gain to the Owners.
	A.	r.	p.	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.		
Donnington -	1728	0	0	681	5	0	380	0	0	301	5	0	1100	0	0		
Swaby - -	1555	1	24	738	5	6	310	14	0	427	11	6	1967	13	0		
Belleau - -	649	1	14	323	8	0	274	0	0	49	8	0					
N. Rauceby -	3168	0	23	1129	16	0	352	0	0	777	16	0	3399	0	0		
S. Ditto - -	2461	0	20	1010	18	7	347	0	0	663	18	7					
Normanby -	1718	3	20	1021	18	3	480	0	0	541	18	3	1820	0	0		
Huttoft -	3352	0	16	2356	2	0	1800	0	0	556	2	0	2300	0	0		
Hemſwell -	2581	2	20	1472	2	6	630	3	0	841	19	6	1874	0	0		
Legburn -	2335	2	3	973	14	7	655	0	0	318	14	7	1663	0	0		
Canwick -	2059	3	33	1437	5	0	672	12	0	764	13	0	1722	0	0		
Skindleby -	1028	1	25	571	3	1	285	0	0	286	3	1	800	0	0		
W. Enderby -	798	0	0	526	4	8	340	0	0	186	4	8	848	10	7		
Anwick fields, &c.	954	0	0	708	19	0	385	3	0	323	16	0	1510	0	0		
Greetham -	1275	0	29	763	2	6	400	0	0	363	2	6	1348	0	0		
Hagg - -	2383	2	13	1806	17	0	1560	0	0	246	17	0	2100	0	0		
Kirton - -	4583	0	0	3864	3	7	1168	0	0	2696	3	7	5267	16	9		
Nettleton -	3549	2	32	1523	17	0	460	0	0	1063	17	9	2425	0	0		
Oſbornby -	1475	2	0	1323	7	0	662	0	0	661	7	0	2032	12	1		
Scarthe - -	1186	2	0	876	15	0	452	0	0	424	15	0	1447	1	6		
Quarrington -	1500	0	0	1268	8	0	627	0	0	641	8	0	3669	0	0		
Sleaford and Holdingham	2321	1	20	2191	2	0	918	0	0	1273	2	0					
Dunſten heath and fields	1957	0	20	1037	1	3	641	0	0	396	1	3	1300	0	0		
Tatterſhall incloſure	4003	2	18	2168	1	11	1706	11	8	461	10	3	626	0	0		
Fens—Ditto embankment	892	0	26	838	13	9	387	19	9	450	14	0	3630	0	0		
Anwick Fen -	1097	0	0	703	16	0	54	17	0	648	19	0	4070	0	0		
The nine embanked fens from Tatterſhall to Lincoln	19,418	1	34	15,534	8	8	1941	16	0	13,592	12	0	77,672	0	0		
Holland Fen 11 towns	22,000	0	0	25,300	0	0	3600	0	0	21,700	0	0	50,600	0	0		
Total -	92,033	2	30	72,150	15	11	21,490	16	5	50,659	19	6	175,191	13	11	8754 11 7	41,905 8 11

ftroyed by diforders, fuch as the rot, &c. In confequence of fuch a fyftem, the markets would not only be better fupplied with fat cattle and fheep, but with different forts of grain and vegetables. Befides, the neceffity of making furrows, drains, ditches, and other paffages for conveying away and removing the fuperabundant furface water, in fuch cafes, would have a great effect in rendering low fwampy fituations more healthy and comfortable for their inhabitants. Much immediate as well as permanent employment would, likewife, be created for the labourer in hufbandry, and the rural artificer; while beggary and robbery, if not wholly prevented, would probably be rendered much lefs frequent.

On population too there can be little doubt but that it would have a good effect, from the great increafe of corn and vegetables of different kinds, as well as of cattle; and, as has been juft obferved, the augmented demand for labourers and artificers of various defcriptions which it muft produce. The facts which we poffefs on the fubject are, however, yet probably too few to draw any certain conclufions from *.

Therefore, in whatever point of view the bufinefs of inclofing common or wafte land may be contemplated, it promifes advantages of the moft important kinds. The humble cottager, the rich proprietor, and the nation at large, muft be equally benefited by the falutary influence of fuch a fyftem, whenever it is allowed to take place.

FENCES.

In the inclofing or dividing of lands, by means of fences, regard is neceffary to be had to a variety of circumftances, fuch as the fize of the farms, and the nature of them, as well as the ufes to which they are to be converted; the climate, the elevation, fituation, and nature of the foils; the particular objects that are in view, or to be expected from them; and the materials of which they are to be formed. It is fufficiently evident that fuch inclofures as are chiefly intended for the production of grafs, ought to be fmaller than thofe in which grain is moftly to be cultivated and grown. On the lighter forts of fandy or gravelly foils, too, the divifions fhould be fmall in proportion to their drynefs, and the particular kinds of crops which can be raifed and cultivated moft commonly, and to the greateft advantage, upon them. And the in-

* Middleton's View of the Agriculture of Middlefex, p. 110.

clofures on fheep downs, and other lands where there is confiderable elevation, fhould, probably, have a reduction of their extent proportioned to their height, and the drynefs of the grounds; the thicknefs of the hedges being, likewife, regulated by the fame circumftances. We are, however, affured, on the authority of an able agricultor, that in forty years' experience he has always found that the grafs would begin to burn, and the grain to fuffer, firft, in a dry fummer, in *fmall inclofures*, and particularly near the hedges. Where the divifions are large, and the foil moift, great care muft be taken in making proper drains to fupply the want of ditches, which anfwer the fame purpofe when properly formed. The frequency of full-grown hedges, high ditch-banks, and trees, on the firft fort of ground, has confiderable effect in preventing fuch lands from becoming too dry, for the fuccefsful growth of different crops. It is ftated by a judicious writer*, that "equal care fhould be taken to guard againft the extremes of too much expofure, and that of creating a thick damp atmofphere, as the health, thrift, and beauty, of animals are greatly promoted by proper fhelter, and a due circulation of air. For inftance," continues he, "a low, flat, and naturally damp fituation, divided into fmall inclofures by high hedges and broad fhaws, efpecially if they abound with trees, is totally unfit for the production of corn crops, and ftill more if it be expofed to a northern afpect, and inclofed with wood. In that cafe the fun is too much excluded, and the damp cannot be fufficiently drained and evaporated to prevent the redundancy of moifture from chilling the better plants, leaving an herbage that will be of no value to a farmer. On the contrary, if it be free from adjoining woods, be drained, and the ditches kept well cleanfed, it would make good permanent pafture or meadow. If, in addition to thefe, the hedges fhould be kept clofely cut or clipt†, the fields large, the trees ‡ trimmed to the height of twelve or fifteen feet, and every poffible method taken to promote the free admiffion of the fun's rays, with a perfect drainage and evaporation, it would be fit for many of the purpofes of aration."

But though the ftagnation of the air in confined fituations, may have an injurious effect on vegetable, as well as animal life, by preventing the proper degree

* Middleton in his View of the Agriculture of Middlefex.

† Where hedges are clipt, they fhould be left wide at the bottom, and tapered up to a ridge at the top; for where they are left broad at top, as is often the cafe, they are apt to fmother the young fhoots below, and the bottom foon grows thin.

‡ There fhould probably be very few trees in hedge-rows.

of evaporation from taking place; it is not lefs injurious to the feeding of animals than the growth of vegetables, when it circulates too much or too rapidly over a diftrict, efpecially where the elevation is confiderable, as in mountainous and hilly fituations; for, in fuch cafes, the warmth of the animals is too fuddenly carried off by the too frequently renewed application of cold air, and the growth of the vegetable thereby much checked and retarded. In fuch fituations, therefore, particular attention ought to be paid in planting the hedges fo as beft to break off the winds they would be the moft expofed to. "It is as well," fays the writer we have juft quoted, "for the purpofe of fhelter, fhade, and equable warmth, as of occafional frefh fupplies of grafs, that the Leicefterfhire graziers have founded their opinion of fifty acres in five inclofures, being equal to fixty in one."

It would feem, therefore, that whether land that is to be inclofed be intended for the purpofes of pafturing, or the production of grain, root, and fuch-like crops; it will be the moft advantageous to avoid the extremes of very large or very fmall inclofures, but that in the latter cafes they may be left more large and open than in the former. From feven or eight to fifteen or even twenty acres, according to the extenfivenefs of the farm, for fuch forts of land as are chiefly to be employed in the way of grazing, may, in general, be the moft proper; and from eight or ten to thirty, in proportion to the magnitude of the farm, in common, may be the moft fuitable for thofe of the arable kind. But whatever be the dimenfions adopted for the inclofures, great attention fhould conftantly be had to the convenience of water, the pofition of the ground, the purpofes of drainage, and the bringing together as much as is eafily practicable lands of a fimilar quality, or fuch as can be cultivated and fown under the fame circumftances, though it may tend to render them unequal in regard to fize, and irregular in form *. Where, indeed, there are no circumftances arifing from the nature of the fituation, that prevents their being formed in a regular manner, the fize of the farms and the courfe of the crops that can be moft beneficially cultivated on them fhould be principally regarded; as by their being thus made to fuit the nature and extent of the farms, conveniences may be gained in the bufinefs of cultivating them, as well as in taking off their products, that no other mode of divifion could probably afford †.

It may on the whole probably be concluded, that the more equable, in refpect

* Anderfon's Effays, vol. I. p. 158.

† Robertfon's View of the Agriculture of the County of Perth.

to temperature, fuch fields as are intended for paftures can be made by means of judicious fencing, provided they be properly drained, and a due circulation of air preferved, the better they will fatten the animals that are kept in them; but that in grounds where grain and root crops are to be cultivated, except in elevated, hilly, and very expofed fituations, the fize of the inclofures fhould be larger, and the fences lefs calculated for the purpofes of fhelter, as the free and equable admiffion of air has great power in rendering the growth of fuch kinds of crops healthy and vigorous, as well as in preventing them from being injured by a variety of caufes to which, under other circumftances, they muft be expofed: befides the health of mankind, as has been already obferved, would, in many cafes, be confiderably benefited by the adoption of fuch a fyftem of inclofure.

Fences are of different kinds, and conftituted of different materials, according to the fituations, and the particular circumftances under which they are made; but, in general, fo far as the farm is concerned, they may be confidered either as walls and pailings, or hedges and ditches.

It muft be obvious, from the nature of thefe different fences, that one kind of them, from its being formed of fome fort or other of dead material, muft, in every inftance, from the very period of its being completed, be conftantly getting worfe, or proceeding to a ftate of decay; while the other, as being compofed of various forts of living plants, where properly managed and attended to, muft be advancing to a ftate of greater improvement and advantage. This difference fully fhews the advantage of having recourfe to one fort of material in preference to the other, wherever there is a poffibility of doing it; but in fome diftricts, and many expofed fituations, it is frequently a matter of great difficulty and expence to procure fuch forts of materials as would be the moft beneficial for the purpofe; in fuch cafes, that fort muft of courfe be employed which is the moft ready and convenient. The dead kind of fences, whether they be formed of ftones, wood, or earth, can feldom, from the expence, be made by the farmer of fuch heights or in fuch ways as to be of much utility in affording fhelter; they will therefore be the moft proper for inclofing with, where that forms no part of the intention of the farmer or proprietor who is making the inclofure. Where this fort of material is employed as a fence on elevated or hilly and expofed fituations, it fhould be conftructed in a more firm manner, and be made to ftand higher, than when ufed in lower and more fheltered fituations.

WALL & EARTH FENCES.

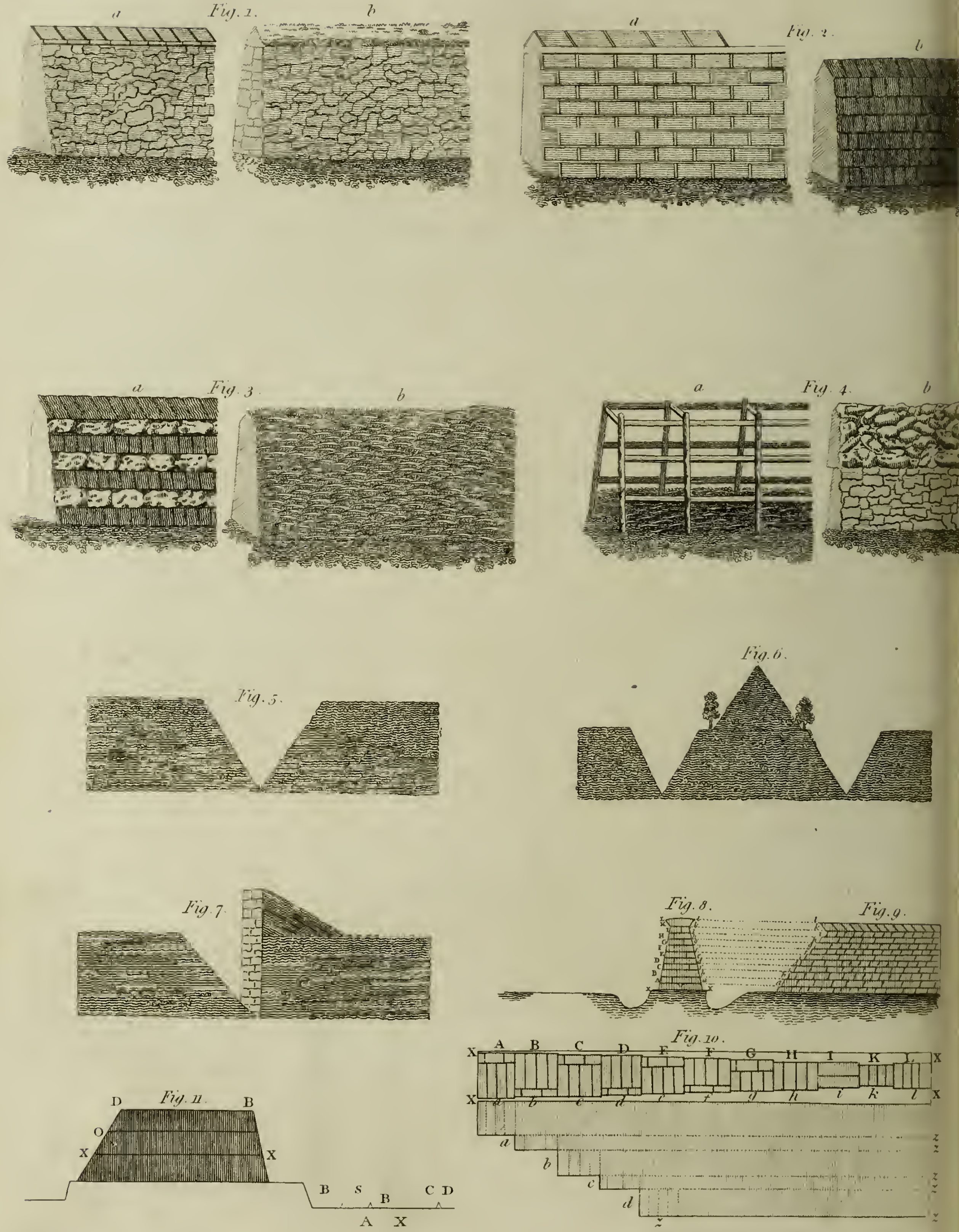


PLATE XXIX.

Wall and Earth Fences.

[*To face Page* 110.]

Fig. 1. Reprefents common ftone walls coped with different forts of materials. At *a* the coping is formed with brick, and at *b* with fod or turf.

Fig. 2. Exhibits the front of a brick wall, and alfo a wall formed wholly of turf: *a* the brick wall; *b* the turf wall.

Fig. 3. Difplays walls conftructed of different forts of fubftances in combination: *a* is a turf and ftone wall; *b* a mud and ftraw wall.

Fig. 4. Comprehends a frame for conftructing mud walls with a dyke wall: *a* the mud wall frame, *b* a gallaway dyke or wall.

Fig. 5. Shows a fimple dyke or ditch fence; the quicks are put in behind the earth thrown up, and protected by a dead hedge behind them.

Fig. 6. Shows the double ditch, the earth taken out being formed into a bank in the middle. Quicks may be planted on one or both the fides of the banks according to circumftances, and protected by hedges when neceffary.

Fig. 7. Is a funk fence faced with ftone. When faced with turf this fort of fence fhould have a flanting form.

Figs. 8. 9. 10. and 11. Reprefent the manner of forming earthen fences, fo as to prevent their crumbling down and being deftroyed. It is recommended by Dr. Anderfon. *Fig.* 8. is a perpendicular fection of it. *Fig.* 9. is a fide view, and *Fig.* 10. a perpendicular view of each row of turfs as it lies in the fence. The mode of conftruction is thus: a long rut *x x x x* fig. 10. is made with the fpade along each fide, with the back to where the fence is to be, fo as to form the cut of the turf flanting outward, as at fig. 8. and 11.: another rut *az* fig. 10. is then made parallel to the former, at the diftance of the length of the turf *a* from it, with the face to the fence, fo as to flope inward as at R, fig. 11. in order that the firft row of turf may be raifed with facility: it is then cut into fods of proper breadth, as at dotted lines *a* fig. 10. which being raifed by the fpade are laid into the fence with the graffy fide undermoft, as at *a* figs. 8. 9. and 10.: the other fide being finifhed in the fame way, the upper furface of the whole courfe is pared fmooth, and clapped down with the back of the fpade for the reception of the next courfe: another row of turf *bz* fig. 10. is then marked off to the diftance of the breadth of that at *b* figs. 8. and 10. from the former, with the face towards the fence; and the through band turf B on the oppofite fide being firft lightly laid, this is put acrofs the ends of them lengthways, fo as to form a fide band *b*, figs. 9. and 10.: another rut *cz* is then formed at the diftance of the length of the turf *e* from the former; but before it is raifed it is neceffary to draw a rut in the line *bz*, with the back towards the fence, which gives it the form BAC, fig. 11. leaving a fmall triangular piece at S; fo that when put up in the fence it has the pofition fhown at BAC, and thus permits the oppofite fide band O to join intimately with it, which would otherwife have projected outward above as to D, fo that the turf O could not have joined it clofely, but have left a triangular opening in the middle, and thus rendered the

fence lefs compact and folid. The work is to proceed in this manner, always rutting the through band rows of turf in both ends, but the fide bands only on one fide, beginning every courfe with thofe that crofs the fence. The top courfe fhould be cut a little longer than thofe below it, and placed with the graffy fide uppermoft, fo as to project a little, as at *L l* fig. 8. or, what is perhaps better, fet on the edge, as in fig. 11.; as by this means the water is not only better thrown off, but the fence rendered more fecure from cattle and the effects of wind. At the foot of the fence a ditch, as XX fig. 8. fhould be dug on each fide, a foot and a half or two feet deep, a ledgelet being left a few inches in breadth, to guard againft the effects of crumbling, keep the foundation dry, and prevent the intrufion of cattle.

PAILING FENCES.

Fig. 1.

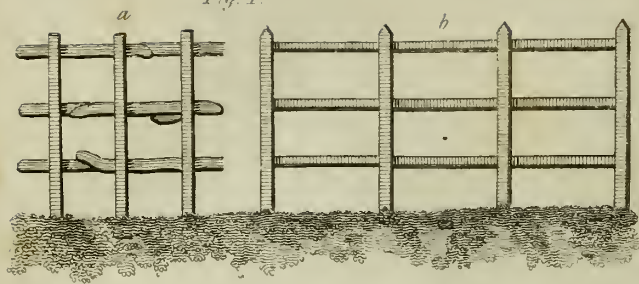


Fig. 2.

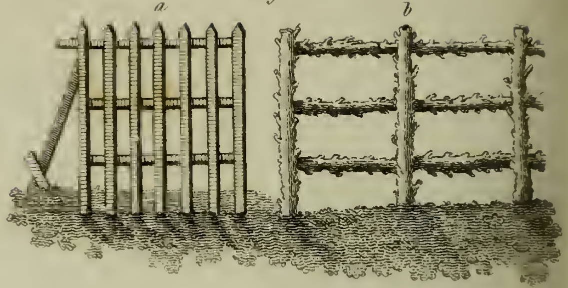


Fig. 3.

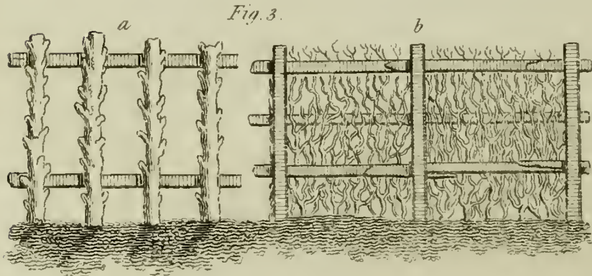


Fig. 4.

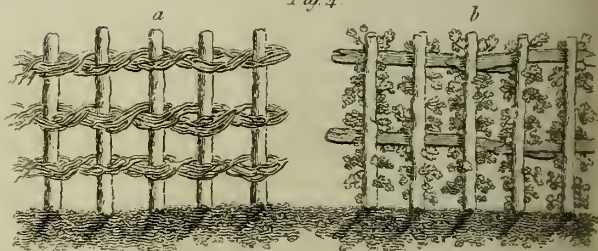


Fig. 5.

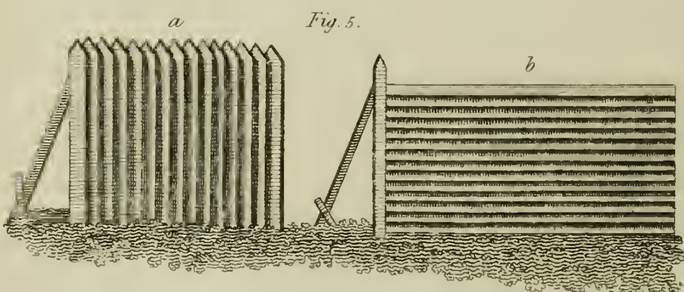


Fig. 6.

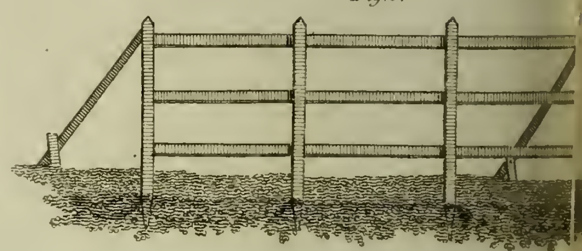


Fig. 7.

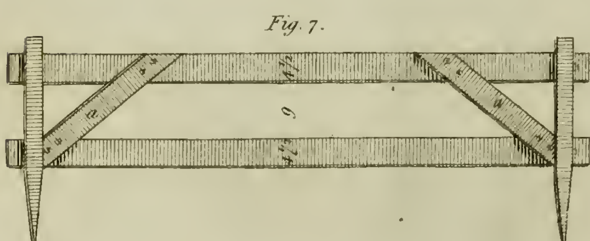


Fig. 8.

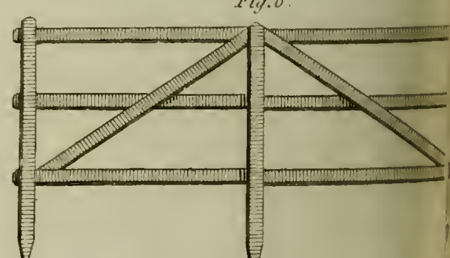


PLATE XXX.

Paling Fences.

[*To face Page* 110.]

Fig. 1. Reprefents two different forts of paling fences: *a*, a coarfe nailed, undreffed, fawn pailing; *b*, a jointed, horizontal, dreffed paling fence.

Fig. 2. Reprefents two other forts of paling fences: *a*, an upright light lath paling, fupported by refts as neceffary; *b*, a fir paling of the horizontal kind, made from the thinnings of trees of that kind, the lateral branches being trimmed off two inches from the ftems.

Fig. 3. Shows two palings of another kind: *a*, an upright fir paling with the branches left as in *b*, fig. 1. *b*, an open nailed paling fence warped with thorns.

Fig. 4. Contains two other forts of fences: *a*, an ozier or willow fence wattled together in three different parts; *b*, a paling fence from growing trees.

Fig. 5. Exhibits two forts of clofe paling: *a*, upright or park-paling; *b*, a lath horizontal paling. Thefe are very ufeful kinds of fences where clofenefs is required.

Fig. 6. Is a moveable or hurdle-fence.

Fig. 7. A lamb-hurdle ufed in Lincolnfhire, for preventing the lambs falling into the ditches of the paftures in ftormy feafons. The fpaces between the rails are clofed by tarpaulin. Mr. Young fuggefts that flit deals may anfwer, being held in their places by the braces *aa*, one of which being moveable, the other fixed with nuts on the rivets, fo as to admit the board to take out occafionally.

Fig. 8. The common hurdle.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

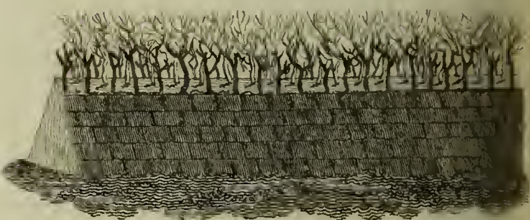


Fig. 5.

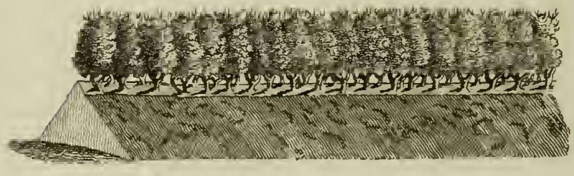


Fig. 6.

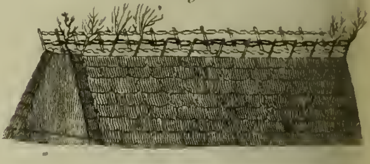


Fig. 7.

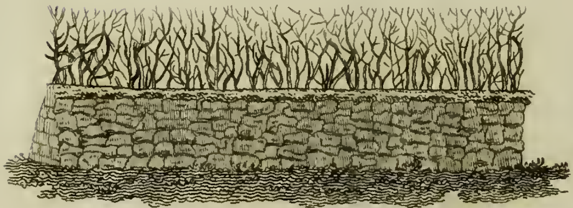


Fig. 8.

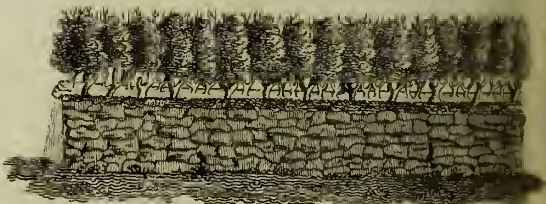


PLATE XXXI.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Reprefents a white-thorn hedge, with the leaves upon it, fo cut and trained as to leave it in the ridge form, or broad at bottom and narrow at the top.

Fig. 2. Is the reprefentation of a hedge in the face of a bank, as defcribed by Mr. Somerville.

Fig. 3 Exhibits a hedge at the bottom of the bank.

Fig. 4 Is a reprefentation of the Devonfhire fence.

Fig. 5. Reprefents a hedge-fence placed on the top of the bank.

Fig. 6. Shows another mode of planting a hedge upon the top of the bank, with the management of the young plants by a protection of willow-hedge, raifed by fetting the ftakes.

Fig. 7. A hedge with a wall.

Fig. 8. Shows a hedge on the wall.

HEDGE FENCES.

Fig. 1.

Fig. 2.

Fig. 3.

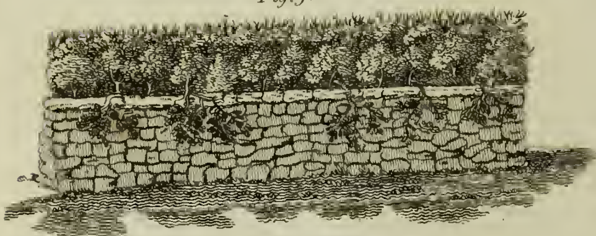


Fig. 4.

Fig. 5.

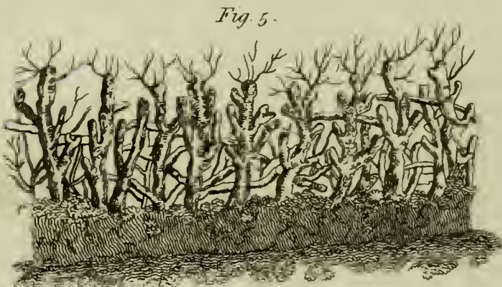


Fig. 6.

Fig. 7.

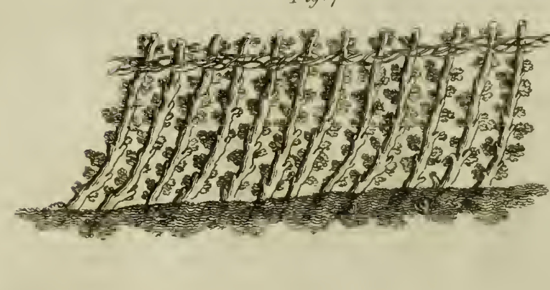


Fig. 8.

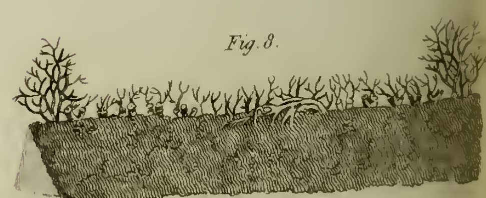


PLATE XXXII.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Is a hedge in the middle of the wall.

Fig. 2. A view of a hedge and ditch with a row of trees on the top.

Fig. 3. A furze or whin hedge on the bank faced with ſtones.

Fig. 4. A furze hedge placed merely on the top of the bank.

Fig. 5. Shows an old hedge cut over, and the young growth of the firſt year upon it.

Fig. 6. Is an old hedge cut over, ſome of the old ſtems left uncut and warped in to fill up the vacancies.

Fig. 7. Repreſents the common quick-hedge, with the ſtems nicked and bent down a little, being then bound at top with willows or hazels.

Fig. 8. Exhibits the method of mending a gap, where the old hedge is cut down, by laying one of the old ſtems, and confining it by hooks, then covering it with earth, ſo as that it may ſend up numerous ſhoots to fill up the vacancy.

HEDGE FENCES.

Fig. 1.

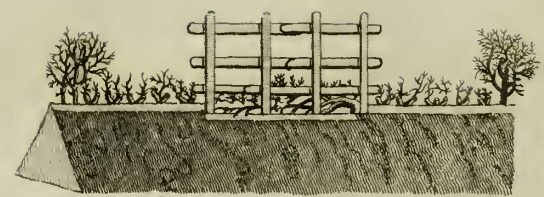


Fig. 2.

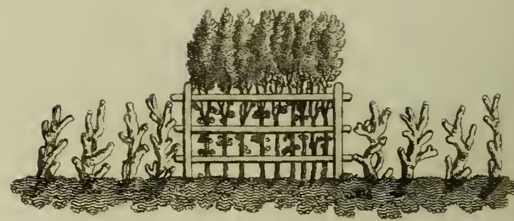


Fig. 3.

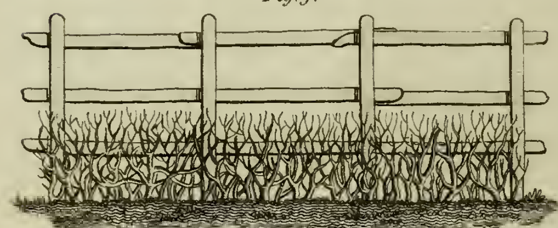


Fig. 4.

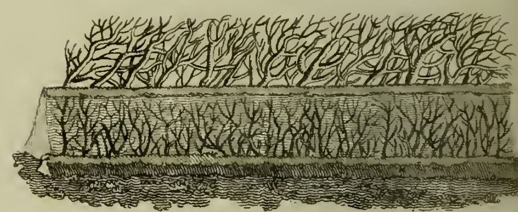


Fig. 5.

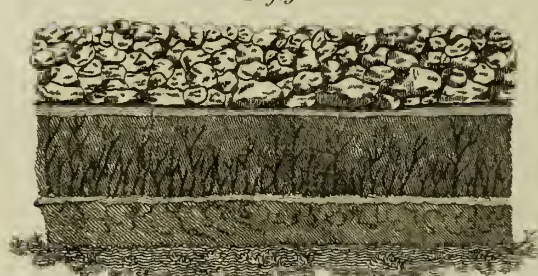


Fig. 6.

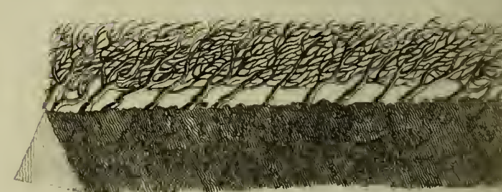


Fig. 7.

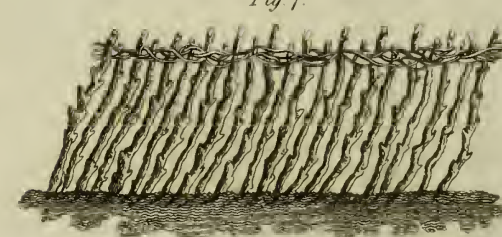


Fig. 8.

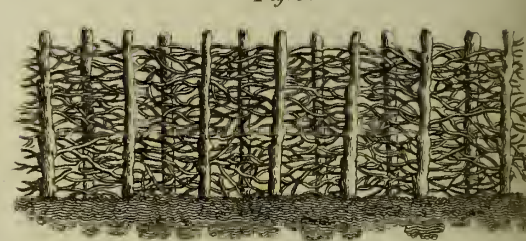


PLATE XXXIII.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Reprefents a hedge repaired in the manner as at fig. 8. Plate XXXII. and protected by a ftrong paling in the opening.

Fig. 2. Exhibits an old thorn-hedge cut down, and an opening repaired by planting young beech trees, protecting them as in fig. 6.

Fig. 3. Is a hedge and paling.

Fig. 4. Is a hedge with a dead hedge on the top of the bank for protecting the young plants.

Fig. 5. A hedge with ditch having a coarfe wall on the bank to protect the plants.

Fig. 6. Reprefents a common dead hedge.

Fig. 7. Shows a dead hedge bound together at the top by edders.

Fig. 8. Reprefents the form of dead hedge ufually termed *ftake* and *band*, and fometimes *ftake* and *rife*. In it the dead materials are wattled in between ftrong ftakes.

WALLS.

Where ftones are abundant, and other forts of materials fcarce, the outfide, as well as the other fences, are frequently made with that fort of material. In the conftruction of walls, different methods are purfued in different diftricts; they are fometimes made fimply of ftones, fometimes with ftones and lime or mortar, but perhaps more frequently by interpofing between the ftones fome earthy fubftance, fuch as clay, mud, turf, or any fimilar matter, and afterwards dafhing or pointing them with mortar or not, according to the particular circumftances of the walls. The firft fort are denominated dry ftone walls; the fecond ftone and lime walls; and the laft earth and ftone walls*. It muft be obvious that where any fort of earthy material is employed in the forming of thefe kinds of fences, they can neither be fo good nor fo durable as where ftones alone, or ftones with lime, are made ufe of, as from the continual action of the air, and the diftending powers of frofts, fuch fubftances quickly decay and moulder away, by which means the ftones are left naked and loofe, and the fences foon become in a ftate of ruin and of little utility. Walls of this nature fhould therefore only be had recourfe to where there are not materials for conftructing the more lafting kinds. Stones, when made into walls in the dry way, if the work be properly executed, conftitute a very good and durable fence; but a better and more lafting, though in many fituations a confiderably more expenfive, method, is that of ufing lime, as by this means the walls are bound and cemented together, and prevented from going away and falling down.

In preparing the ground for the foundation of walls, it fhould always be dug up to fuch a depth as that the froft may have no effect on it; where the furface of the earth is fufficiently level, it is found a more preferable method to lay the foundation of walls on the turf than in a flight trench only, as in this way they are not probably fo liable to fink and give way. The foundation or bottom of this fort of walls fhould be two feet and an half wide, and the upper part from ten to fifteen or twenty inches, according to their height, which muft vary in proportion to the nature of the fituation and other circumftances; but from five to fix feet is a very common and good height. They fhould always be coped at the top, either by means of ftones laid edgeways, or with turf about fix inches in thicknefs, put on in the form of an arch; the former is, however, by

* In fome places this fort of fence is termed *dyke*.

far the moft advifable method, as being the moft durable, and affording much difficulties to animals in their attempts to get over.

In fome places walls are made partly with a cement, and partly dry, and are termed *lift walls;* but where a flat bed of ftone can be had, they are generally conftructed without the ufe of any cement whatever, and if the work be well executed, they will continue a long time. In the building of dry ftone walls, two mafons ought conftantly to be employed oppofite to each other, in order that the furface of their work may be kept perfectly level. Long ftones fhould likewife be felected for the purpofe of being placed occafionally acrofs the wall, in order to bind it well together. Thefe are termed *throughs*, or *through ftones*, and are commonly put about the middle of the work, in the proportion of nine or ten to every rood of feven yards.

The expences of building thefe different forts of walls in Somerfetfhire, Mr. Billingfley ftates, to be per rope of twenty feet as follows:—

LIST WALL.

	£.	s.	d.
To quarring or digging eight loads of ftone (25 cwt. each), at 3d.	0	2	0
To halling the fame, fuppofing the diftance half a mile, at 6d.	0	4	0
To building per rope (twenty feet), at 3s. 6d. - -	0	3	6
To feven bufhels of lime, at 3d. - - -	0	1	9
To covering with turf (if done very well) - -	0	0	3
	*£.0	11	6

DRY STONE WALL.

	£.	s.	d.
To quarring as before - - - -	0	2	0
To halling ditto - - - - -	0	4	0
To building, at 2s. - - - -	0	2	0
To turfing - - - - -	0	0	3
	£.0	8	3

* In confequence of the advanced price of wages and of coal, fifteen or twenty per cent muft now be added to thefe calculations.

When ftones can be got within a wheeling diftance, or about fixty or feventy yards, it is obferved that the coft will be reduced about two fhillings a rope; and that if the wall be wholly made with cement, it will be enhanced about two fhillings and fix pence the rope.

And in Northumberland the charge for *winning and walling* is from five fhillings and fix pence, to fix fhillings and fix pence the rood, of feven yards.

The ftones employed in the conftructing of every fort of wall fhould be rendered of as flat a form as poffible, either by quarrying, or fome other means, before they are made ufe of; as by fuch a practice fences of this fort are not only conftructed with much greater facility and expedition, but become far more ftrong and durable.

In building of walls with ftone and lime, the early part of the fpring or the beginning of autumn feem by much the moft fuitable periods for the purpofe, as they cannot at fuch feafons be much injured either by the deftructive effects of froft, or the too drying properties of great heat.

In the forming of walls, or what in fome diftricts are termed dykes, with earthy materials, or with a mixture of ftones and fuch fubftances, the methods that are followed vary according to the circumftances of the particular cafes. In fome, two or three feet at the bottom is conftructed with dry round or flat ftones, in a floping direction, upon which a coping of broad flat ftones is laid, fo as to project a little upon the fides, upon which rough ftones are again placed fo as to form a kind of ridge: in other inftances wrought clay is employed in the way of mortar between each courfe of ftone; and in others again turf cut from the furface of the land is intermixed with ftones taken from the fields, layer upon layer. This laft is a kind of fence that may be formed in almoft any fituation at a trifling expence, and which may ferve the purpofes of temporary inclofure in many cafes. But if the ftones be left out, and the whole wall or bank be raifed in a floping direction with turfs well filled up behind, a ftill more firm and folid fence may be made.

On ftone walls Mr. Middleton very juftly obferves, that "fo far as the mere purpofe of a fence is intended or defired they are the beft of all, as they occafion the leaft wafte of ground, do no injury to the corn crops, do not harbour vermin, and are free from the weeds and rubbifh that invariably accompany live hedges. Nor be it forgotten," continues he, "that they nearly exclude the greateft of all vermin, to a cultivated country, *hunters**."

* View of the Agriculture of Middlefex.

It is remarked by an accurate practical obferver, that the greateft part of the walls or dykes of the kind that have been juft defcribed, which he has feen, were made of a confiderable thicknefs, with a ditch on each fide; the heart of the dyke being made up with the earth that had been taken from the ditches, and only a thin facing on each fide was built of folid *feal* (turf) from top to bottom; " the confequence," fays he, " of which is, that as the loofe earth that is thrown into the middle of the dyke fubfides much more than the feal on each fide, the top of the dyke finks, and of courfe the two fide-walls are preffed too much upon the infide, fo as to *bilge* (or fwell) out about the middle, and quickly crumble down to duft." To avoid this inconvenience, he has always chofen to build dykes of this fort much thinner than ufual, they being only three feet and a half or four feet thick at the bottom, fifteen or eighteen inches at top, and five feet high, taking care to have them built in fuch a manner as that every fod (feal) from top to bottom binds the joinings of the others below it, with as much accuracy as the bricks in a well-built wall. The uppermoft courfe of feal is cut a little longer than thofe that are immediately below it, and placed with the graffy fide uppermoft, fo as to project a little on each fide, which is not only of ufe to throw the water a little off the wall or dyke, but is alfo of ufe in preventing fheep or cattle from attempting to jump over it fo readily as they otherwife might do. Further experience has, however, taught him, that in many cafes the coping will be more durable if it confift of a row of feal fet on edge; for when the flat-laid *feal* are withered by the fun in fummer, they become very light, and are apt to be blown off by the wind fingly; whereas, when they are fet on edge, as they lean upon each other, they are bound fo firmly together, that no fingle one can be carried off. He has likewife found, that a wall, whofe foundation is ftone, though perhaps the ftones rofe no more than a foot, or a foot and a half high, having the upper part finifhed with feal, or of alternate layers of ftone and feal, if the dimenfions are the fame as if it were compofed entirely of feal, is probably more durable than any other kind of fence compofed wholly of either of thefe materials.

At the foot of the wall or dyke, on either fide, is dug a fmall ditch about a foot and a half, or two feet deep, leaving a ledget of a few inches broad on each fide, that the dyke may not be undermined by the crumbling down of the loofe earth into the ditch. " Thefe ditches," he fays, " not only help to give the dyke an additional height, and keep its foundation dry, but are alfo of ufe to prevent cattle from coming clofe to it, and rubbing upon it, or tearing it down with their horns, which they are very apt to do if this precaution be omitted."

In refpect to dry ftone dykes, or walls, he obferves, that "if you live in a country where good free-ftone can be eafily got, and lime can be procured at a moderate price, a dyke built of thefe materials will be little lefs durable than a hedge; although, in general, it will neither be fo cheap nor fo agreeable. But that dry ftone dykes, unlefs built of the fineft quarried ftone, are of fuch a perifhable nature, as to be fcarcely ever worth the expence of rearing; unlefs the field that you would wifh to inclofe has plenty of ftones upon itfelf, which muft be carried off from its furface before the field can be improved. In fuch a fituation," he fays, "a man may in fome meafure be excufed if he fhould be tempted to put the ftones into dykes; becaufe the carriage of thefe materials may be faid to coft him nothing, and he might perhaps be at a lofs how to difpofe of them in any other manner. But in all other circumftances he apprehends it is very bad economy to rear fences of this kind, as earthen or feal dykes can always be built at about one-fourth part of the expence that thefe would coft, will anfwer all purpofes equally well, and if carefully built may be kept in repair for any number of years, at a very fmall expence*."

It is likewife fuggefted that by having the joints in thefe fences bound in all directions, the whole is rendered more firm and compact than it could be made in any other way, and at the fame time more readily formed. And that as the chief inconveniences to which they are expofed are thofe of their being liable to be torn or rubbed down by cattle, and to moulder away by the effects of froft, and the action of the air, it might often be advantageous to fet the banks with ivy fweet-briar, furz, or fome fuch kinds of plants, in order to protect them.

As earthen walls, or fences of that nature, can be formed in moft fituations in the way that has been defcribed, at the expence of three halfpence or two pence a yard, they feem well calculated for inclofing where cheapnefs is a primary object.

Walls conftructed in many of the modes that have been mentioned above, may frequently be made either more durable, or more ornamental, by being *dafhed*, *lipped*, or *harled* with lime.

For a limited number of years, where ftones can be eafily procured, there can probably be little doubt but that walled fences may be preferable to moft other kinds, as they can be readily repaired in cafes of accident, and keep cattle very fecure. Where the land is poor too, with much expofure to violent and defolating winds, fo that live hedges cannot be eafily raifed, they may be found the moft advantageous fort of fences.

* Anderfon's Effays, vol. I. p. 7.

PAILINGS.

Fences constructed of timber can in but very few situations be advantageously employed for the purpose of inclosing land, except for parks and pleasure grounds, or they be formed of the coarser sorts of wood, and placed on the banks or sides of ditches, for the protection of young thorn or other hedges, and for the dividing of fields, as occupying little room, and other uses of the same nature.

The most cheap and common sort of pailing made use of for the inclosing of farms is that in which two, three, and sometimes four long pieces of timber, but little dressed or prepared, are nailed in a longitudinal direction to upright posts of different thicknesses, according to circumstances, firmly set or drove into the ground. In some cases these fences are rendered more firm, strong, and durable, by having triangular pieces of sown wood fastened lengthways upon the tops of the posts, by nails or wooden pins, with one of the edges upwards, so as to convey away and cover them from being injured by the effects of water. This is a much better and cheaper mode than that of making holes in the top pieces, in order to admit the heads of the posts to pass through them; or than that of inserting them into the posts, by means of mortices made in them.

Where there are coppices of young wood, either of fir, ash, or other kinds, fences of this nature may be formed at very small expence by the trimmings from them, as the work may be performed by any common ingenious labourer. Care should, however, always be taken that the horizontal pieces be not fixed at too great distances from each other, as where this is not sufficiently attended to, much inconvenience may be sustained by animals creeping between them.

But a better sort of farm pailing may be constructed by having the posts hewen, and considerably thicker, and mortices formed in them to receive the longitudinal pieces. This, however, though certainly a more neat, and probably, in most cases, a more lasting kind of fence, is attended with much more expence. As the cutting of mortices is liable to weaken the posts, and by admitting water to decay them, it has been suggested to attach the cross or horizontal pieces to them by means of strong iron staples*. Iron is, however, very subject to be destroyed by the action of air and moisture, except it be kept constantly well covered with paint, which is not only troublesome, but expensive.

* Somerville in Communications to the Board of Agriculture, vol. II.

There are ftill other kinds of pailings that may be employed as fences in particular cafes. Where fuch pieces of timber as are proper for rails are fcarce, a good fence may be formed by only having one nailed at the top, and another at the bottom, to the upright pofts; or, indeed, by having only one at the top, the middle being filled up by nailing fhort thin upright pieces upon them, at the diftance of fix or eight inches from each other, being in the latter way left longer, and drove well into the ground. The flips or laths in this fort of fence, as they are but fhort, may be eafily procured from fuch kinds of wood as are the leaft valuable, and which cannot be ufed for many other purpofes. Such, for inftance, as may have been procured from the lopping of timber trees, or the thinning of plantations; but in all cafes they fhould be well feafoned before they are made ufe of, as green wood not only foon decays, but is quickly torn by the action of the fun.

From the clofenefs of this fort of fence, it feems well calculated for fuch inclofures as are to be kept in a ftate of pafturage, and where young quick hedges of any kind are to be protected and kept from the cropping of cattle.

A clofe kind of fence may likewife be made by nailing upon any of the above framings, either in a longitudinal or upright direction, pieces of fir, or any kind of timber, roughly fown into pails of about an inch in thicknefs, and of fuch breadths as the timber will allow, fo as flightly to lap over the edges of each other. When nailed on lengthwife, the upright pofts muft be placed in the ground, at fuitable diftances for the length of the coarfe pails or fhingles.

There is a kind of moveable pailing-fence that may frequently be of utility in dividing inclofures or confining fheep and other forts of animals, while they are feeding on different forts of vegetable productions, which would be much injured, and not fed off fo economically, if they were not confined by fome fuch means. This is the hurdle-fence, which may be made of any fmall fort of wood, but fuch kinds as are the lighteft in proportion to their fize fhould be preferred. On this account the willow, the poplar, and the alder, when well dried and feafoned, may be highly ufeful for the purpofe of framed hurdles. Good hurdles may likewife be made by wattling young hazle plants, or others of a fimilar kind, between upright ftandards. Thefe are not, however, fo neat as the former, but in general are much cheaper. Where the framed hurdle is made ufe of, it is rendered confiderably more ready and convenient, as well as more durable, though a little more expenfive, by having the parts that are to be placed in the ground pointed with iron. Where this is done a hurdle fence can be fet down in a very fhort time. In fome cafes it might likewife be of great utility to have fmall

iron loops and gudgeons at the upper parts, fo as that the whole fence might be connected from one end to the other by them.

In the erecting of all forts of pailing-fences, but efpecially fuch as are of the more expenfive kinds, as thofe for parks and pleafure-grounds, great attention fhould be paid to having the pofts of fufficient length, in order that they may be fet to a good depth in the ground; as without this be done, and the poft-holes well rammed up, they are very liable to be pufhed and blown down, or become irregular in their appearance. The depths to which the pofts ought to be placed into the ground, muft vary according to the nature of the foil, and the height and kind of pailing, but where it is clofe or of much height, from two to three feet is, in general, little enough. Such a feafon fhould always be chofen for putting down the pofts, as that they may be well rammed up at the time. In wet feafons this fort of bufinefs cannot, by any means, be effectually performed; a rather dry period is to be preferred. As fomething of the nature of putrid fermentation is apt to take place about the part where the pofts come above the ground, by which the wood is foon mouldered and decayed away, it is neceffary to guard againft it as much as poffible, by preparing them in fome way or other. From charcoal being known to be highly indeftructible, pofts have been charred at the bottoms with this view, and where the operation is well and cautioufly performed, it may be a very ufeful method. The application of tar and different forts of oil paints has, likewife, been made with the fame intention; but as all fuch applications are foon difcompofed when placed in contact with the moift earth, they can of courfe only refift the decay for a very fhort time. Of thefe fubftances, thofe which penetrate the wood the moft, are always to be preferred, which fhould be applied when the wood is perfectly dry and free from moifture, and the pofts be left for fome time before they are put into the ground.

Where pofts can be had with the bark wholly upon them, efpecially if they have been cut at a proper feafon, no application of any fort will be neceffary, as this covering is found to refift decay much longer than any artificial application of the nature of paint.

Much advantage may often be gained in preventing the decay of pofts, by the ground on which they are placed been raifed into a fort of fharp ridge, fo that the water may never be fuffered to ftagnate about them, the holes being made up rather higher than any other part, a circumftance which is feldom much regarded.

For the covering of farm pailings, tar, as being a cheap fubftance, when good and well boiled, with a little ocre for the purpofe of thickening and giving it a

body, is probably the moft ufeful general application. It fhould always be laid on in as hot a ftate as poffible, and the wood at the time be as free as poffible from moifture. Coal oil, if it could be rendered of a rather more thick confiftence, might probably be employed for thefe coarfe purpofes with great advantage; but when ufed in the form of paint, it is liable to become flaky, and peel off.

HEDGES.

In the raifing of quick hedges, the planter fhould always have attention to the nature of the foil, and the fituation of the ground, and of courfe adapt his plants to them; which may, in moft inftances, be done by attending to the growth of fuch plants as are already on the land; and he may employ either one, or a mixture of different kinds of plants, for the purpofe; but the latter practice is not, in general, to be recommended. On dry and tolerably good foils, efpecially for outfide fences, the white and black thorns ought always to be preferred. The latter is not, however, fo certain a grower, except the ground have a rich and rather dry friable mould; but it is more lafting, and not fo liable to be cropped by cattle.

Some practical planters think, however, that black thorns fhould never be put in, except upon very cold and wet land, where white-thorns will not grow; and that crab-fets are even in thefe cafes much better; as they grow flow, make a forry weak fence, and are fure to run and fpread out into the inclofures.

In low fituations, where there is much furface water, and where the foil is rather loofe and retentive of moifture, the farmer may have recourfe to plants of the willow tribe for the forming of his hedges, as under fuch circumftance they grow not only with great rapidity and vigour, but are capable of being converted to a great variety of ufeful purpofes.

They do not, however, make a very good fence, and are fometimes apt to prove injurious to cattle, by their cropping and eating the young fhoots too freely. Young cattle have been known to be killed by them. Where cattle are to be paftured, it is therefore better to have recourfe to white-thorns, as they may be very well raifed upon fuch foils, by care being taken in their planting to raife the ground where they are placed with tw or three table turfs.

On thofe dry and fandy banks where there is not fufficient depth of foil for the fupport of the thorn, furze makes a tolerable fence, provided it be not fuffered to grow too high, and be clipped or cut at proper feafons.

But on fuch banks as are liable to be carried away by the wafhings of ftreams

of water, the alder and the willow may be planted with confiderable advantage, as by throwing out a great number of branches from their roots, they afford great fupport to fuch banks.

And in very expofed and elevated fituations, the beech and the birch will probably be found the moft proper plants for raifing live hedges with, as experience has fhewn that, by proper attention, in fuch places they form good fences in a fhort time.

Wherever a mixture of different forts of plants is employed in making a hedge, fuch fhould always be chofen as are capable of thriving well on the fame kind of foil, and in the fame kind of fituation, as well as of growing with nearly equal degrees of ftrength; for without this a very imperfect fence muft be formed, as while fome of the plants are getting forward with great vigour and luxuriance, others will proceed in a very feeble and fickly manner, from being checked by the fhade and obftruction caufed by the larger ones, thus rendering it thin, uneven, and defective. Befide, fome forts of plants, by being blended with others in the making of live hedges, have a difpofition to fmother and deftroy them, by too clofely uniting with, or intwining round them. Honey-fuckles, brambles, and many other plants of the fame nature, have conftantly a tendency to produce fuch effects in hedges.

Before any kind of quick hedge is planted, the line of ground on which it is to be placed fhould be ploughed or dug up, and undergo fuch a degree of preparation, as will render the foil, of whatever kind it may be, perfectly mellow and friable, as well as lefs difpofed to throw up weeds; as by fuch means the fibres of the plants will not only be more readily enabled to fhoot out and eftablifh themfelves in the ground, but the plants be lefs liable to injury from the effects of weeds; from both of which caufes young hedges often fuffer greatly when the plants are put in, in the common mode, without the ground being fcarcely in any way prepared for their reception. In fome inftances, perhaps, as where the foil is extremely ftiff and tenacious, fuch kinds of manures as have a tendency to leffen the cohefion, may be of much utility; but in other cafes they do not feem to be fo particularly neceffary.

After the ground has been thus well broke down and rendered fuitable for the young plants, the next thing is to put them in. This fhould always be done in the early part of autumn, in order that the earth or mould may fall down and get well fixed about their root fibres before the winter frofts fet in. When planted in early fpring, which is frequently the practice, we have not found them to thrive by any means fo well, and to be much more liable to injury from the

heats of the fpring and fummer, as they are feldom well fixed in the foil before thefe take place. Befide, it frequently happens, efpecially in the more northern fituations, that the frofts continue fo long as to protract their being planted out to a period when they can hardly be expected to fucceed.

In the firft mode, if fufficient care has been taken not to injure the roots of the plants in trimming and taking them up, they fucceed with great certainty, and make a very rapid growth, frequently becoming a hedge a year or two fooner than when treated in the common method.

It has been moft commonly recommended to take the plants for the purpofe of making quick thorn-hedges with, from the moft poor and worft kinds of foil, as by fuch means it has been thought that they would grow more vigoroufly when removed into fuch as are of a richer quality. It muft, however, be confidered, that fuch plants as have been ftunted in their growth, or grown in a feeble and fickly manner, are not only a long time in recovering themfelves, but at laft feldom thrive fo vigoroufly as thofe which have been procured from a rich fituation. It is obferved by an able writer, that "he has found, from reiterated experiment, that a ftrong and vigorous plant, which has grown up quickly, and arrived at a confiderable magnitude in a very fhort time, never fails to grow better after tranfplanting, than another of the fame fize that is older and more ftinted in its growth, whether the foil in which they are planted be rich or poor: fo that, inftead of recommending a poor hungry foil for a nurfery, he would, in all cafes, wifh to fet apart for this purpofe the richeft and moft fertile fpot that could be found; and, in the choice of plants, would always prefer the youngeft and moft healthy to fuch as were older, if of an equal fize. That he fpeaks here from experience, and therefore does it without the fmalleft doubt or hefitation; being certain that future obfervations will confirm the juftnefs of the remarks*."

As it has been found, by various practical trials in forming white-thorn hedges, that fuch plants fucceed the beft as poffefs the greateft number of fibrous roots about the bottom of their ftems, it is a matter of importance to adopt fuch methods as tend to produce fuch effects while they are in the nurfery. This may, probably, be much effected by tranfplanting at an early period, as the firft or fecond year, and lopping off all fuch roots as have a tendency to ftrike directly downwards, or to extend too much in a lateral direction, the plants being placed in a very rich foil, and kept at a good diftance from each other, in

* Anderfon's Effays, vol. I.

order that they may not only grow ftrongly, but that the ground between them may be rendered fufficiently clean. It is remarked by the ingenious author juft mentioned, "that in the winter fucceeding the time the thorns have been tranfplanted, the earth between the rows ought to be dug over with the fpade, taking care to go very clofe to the rows, and to work with a very fharp-edged tool, the operator always taking care to force his fpade ftraight down, with the back of the fpade towards the thorns on each fide of the row, as clofe to it as poffible, fo as to cut the greateft part of the lateral roots as near the body of the plants as may be, which will tend to make them branch out into ftill more numerous ramifications. And if the ground be dug every winter afterwards, keeping at a little greater diftance from the plant at each fucceffive digging, the roots will be kept at all times fo fhort, and their ramifications will be fo numerous near the ftem, that when they fhall be lifted to be put into the hedge, they will not fail to be provided with fuch an abundance of mouths to imbibe nourifhment with, as to be in no danger of fuffering much by that operation. If," continues he, "the foil of the nurfery be fufficiently rich, and if the thorns have been tranfplanted while young, and early in winter, they will rufh up chiefly in height, and fend out but few lateral branches; which is a thing much to be wifhed for in a nurfery; therefore care ought to be taken, when they are firft tranfplanted, not to bruife or injure the ftem of the plant, nor, on almoft any account, to cut it over, unlefs the ftem was before fickly and ftinted. Neither ought the upright fhoots to be in any cafe fhortened while in the nurfery: but to facilitate the operations between the rows, any ftraggling fide-branches that may fpring out, ought to be cut off by the knife, or fhears, at the beginning of winter.

"In every fituation it will," he fays, "be proper that the earth between the rows be ftirred the firft winter *by the fpade*; but if the nurfery is of great extent, it may be afterwards done by means of the plough, with the utmoft facility*."

Between the rows of quicks, where fuch large fpaces are left, various kinds of garden crops of the dwarf kind might be cultivated to advantage, fuch as peas, turnips, fpinach, and onions.

In collecting plants for forming thorn hedges, it has been generally the cuftom to prefer fuch as are very young and fmall; but it is probably a much better, as well as more expeditious practice, where they can be procured, to have them

* Anderfon's Effays, vol. I.

much older and larger; as where the plants are of a confiderable fize, the hedge is not only much more readily formed, but the plants far lefs liable to be injured by the feverity of the winter feafon, or the heat of the fummer, and require a great deal lefs nurfing and protection, than where very young plants are made ufe of. In ufing plants of a large fize, care fhould, however, conftantly be taken to have their roots preferved as much as poffible.

But whatever fort or fize of plants be employed, it is a neceffary circumftance to have all fuch as are to be planted in the fame fence, as nearly of the fame vigour of growth and dimenfions as poffible; as by proper attention in this refpect the fence will be lefs in danger of having gaps and thin places formed in it, which muft otherwife be the cafe from the inequality of the growth of different fized plants. Befides, by properly forting them, the farmer may be more enabled to adapt them to the particular circumftances of the foil and fituation of his land.

In preparing the quicks for planting, whatever the age or fize may be, the roots fhould be but very little touched by the knife, as it is always of advantage to the growth of the plants to have as many root fibres as poffible remaining. Some part of the tops of fuch plants fhould, however, conftantly be cut away, as from the injury which their roots fuftain in tranfplanting, they can feldom or ever fupply a fufficiency of nourifhment to preferve them from decay; in the older forts of plants more freedom in cutting may, however, be ufed, than in fuch as are young.

The methods of planting live hedges vary confiderably in different diftricts, according to the cuftoms and kinds of plants that are employed. In fome cafes the plants are placed in an horizontal direction upon fods turned mould-fide upwards, in the face of *ditch-banks*, *mounds*, or *walls*; and covered up fo as to have but a few inches of the plants without, in order that not more than one or two vigorous fhoots may be thrown out by each. In this mode of planting, a good bed of mould fhould be made for the reception of the roots of the plants, as well as covering them well up, as by this means they will be found to thrive much better.

It is remarked, on the authority of much experience, that " the proper method of planting this kind of hedge is, firft to turn up a little of the earth from the place where the ditch is to be made, and lay it upon the bank reverfed, fo as to form a bed for the plant about two inches thick above the folid ground. Upon this the thorns fhould be laid nearly in a horizontal pofition, but inclining a little upward in the point, and having the ends of the ftems juft equal

with the face of the bank, or projecting beyond it very little, not more than half an inch. By this means, it is thought, the plants will fend out only one or two fhoots each, which will be the more vigorous, as there are fo few of them. Where a greater number of fhoots are fent out in any plant, it will be proper," it is faid, "to prune away all the fupernumeraries the firft winter after planting, cutting them with a knife clofe by the ftem from which they fpring: for it is the largenefs of thefe original ftamina of the hedge that will afterwards conftitute its ftrength, and not the number of fmall ramifications, as is too generally imagined. If the fhoots are numerous, they never acquire fuch a degree of ftrength as when there are fewer of them. But an eafier way ftill is, to rub off the fupernumerary buds as foon as they begin to fhoot in the fpring. The plants being thus regularly laid, fhould have their roots immediately covered with the beft mould taken from the furface of the ditch; and the workmen fhould take care to keep that good mould well back upon the bank, and rather behind the roots, leaving the breaft of the bank to be made up by the lefs fertile earth taken from the bottom of the ditch. By this means the roots will have all the good earth about them, in which they will fpread with freedom, and draw from it abundant nourifhment; and the bad earth, which forms the breaft of the bank, will produce much fewer weeds there than the good earth would have done, if it had been kept near the furface*."

As the hawthorn is, however, known to be impatient of much wet refting near the roots, it ought never to be planted by the fides or on the edges of ditches that have much ftagnant water in them. The common method of planting quicks on the borders of ditches, near to the banks, is, indeed, in moft cafes and fituations, a bad practice; for whatever the nature of the foil may be, from the effects of the weather, and various other caufes, the mould on their fides is conftantly removing itfelf, and leaving the roots of the plants expofed and without fupport.

In fome diftricts the banks on which the quicks are planted are made fix feet wide at the bottom, three and a half at the top, and two feet in height. Some planters likewife prefer a ditch on each fide, about three feet wide, and two feet deep, the fides being made in a floping direction, and the bottoms not wider than fix inches; while others only make one ditch, the earth on the oppofite fide being pared off to a flope. Some prefer earth mounds, planting the quicks upon a turned fod, fix inches high at their bafis, and on the edges of the

* Anderfon's Effays, vol. I.

ditches out of which they are raifed. Where this mode is followed, it would, probably, be better to plant three fods high, with the thicknefs of two furface fods put under their roots. In this way the furface foil is in moft cafes doubled, and in the thinner forts of foils nearly trebled, and a thick bed of the beft earth is formed for the quicks to grow in.

Where young quicks are to be planted, it has been recommended that the bank fhould be fufficiently wide, for inftance, not lefs than four feet wide at the top, that room may be allowed for planting two rows, at two feet or more afunder, on the flat furface of the bank; care being taken that the roots be inferted into the beft mould, and that the fides be floped in fuch a manner as effectually to prevent their crumbling down, with a ditch on each fide. And in order to prevent the depredations of cattle, thorns may be placed loofely in the ditches. This method faves the heavy expence of pofts and rails, or dead hedges, as cattle cannot ftand nearer the ftems of the quicks than fix feet, which is fufficient to prevent their being deftroyed*. Mr. Billingfley has not, however, found this plan to fucceed well in Somerfetfhire.

In making quickfet hedges, Mr. Middleton likewife thinks it would, probably, be an improvement on the practice which has been generally followed, to put two rows of quicks in, at about a foot and a half or two feet from each other, which on growing up might be cut alternately every five or fix years. The cut wood being by this means ten or twelve years old, and that left for a fence five or fix; which would be fufficient for a fence, as well as for the protection of the young fhoots on one fide from being cropped by cattle, while on the other they might be guarded by dead thorns thrown into the ditch. By this plan, hedges would, he fuppofes, become extremely profitable to the farmers. "But the method," fays he, "above all others the beft, if it fhould be found to fucceed, as it probably may, on a moift foil in a moift climate, is the grubbing of thorns five or fix feet high, in copfes, &c. trimming the roots, and planting them clofely on one fpit of the beft mould laid on the turf. This fhould be taken from where the ditches are intended to be made, and chopped well to pieces. Then raife a bank on their roots round their ftems at leaft three feet high, and cut their tops level, two feet above the bank."

Of the advantage of this mode of making a quick fence at once, we are in fome meafure convinced by the trials we have made. It is neceffary, however, to the complete fuccefs of the plan, that the quicks be taken up with care, be

* Middleton's View of the Agriculture of Middlefex.

planted at a proper feafon, and have a confiderable depth of fine mould for the fibres of the roots to fhoot into. A mixture of nearly equal parts of the fcrapings of roads and good rich mould we have found them to grow by much the beft in. If the feafon be dry for fome time after they have been planted, it will fometimes be neceffary to water the earth frequently about their roots.

Where the plants are put in upon banks, of whatever kind they may be, they fhould always be placed fufficiently back, in order to prevent their being carried away by the crumbling down of the fides, and that they may be kept free from weeds, and the mould be better laid to them; inftead of the common diftance of four or five inches, it fhould probably be feldom lefs than ten or twelve.

The large banks made by having double ditches are not, perhaps, to be adopted, but in very wet fituations, as they take up a great deal of land without affording any advantage over the fimple ditch. One ditch properly made will be enabled to carry off the water equally as well as two; nor is a double row of plants to be had recourfe to but in particular expofed places; as a fingle row, when attention is paid in putting them into the bank, will be quite fufficient for the forming of a good hedge.

High banks, in whatever manner they may be made, feem only to be neceffary in fuch foils as are cold, wet, and fubject to the ftagnation of moifture at particular feafons.

Where ditches on the fides are required, they fhould conftantly be made to flope down in fuch a way as not to be wider than fix inches at the bottom, as by this means the cattle will, in fome meafure, be prevented from walking in them, and eating the young fhoots. Care fhould likewife be taken in performing this bufinefs, that none of the ftiff bad earth from the bottom of the ditches be thrown into the middle of the bank where the quicks are to be fet, as it would retard their growth very materially, and, in fome cafes, perhaps, entirely deftroy them.

In other inftances the quicks are planted on the plain furface without any bank being raifed, a furrow being formed with a common plough, or a fpit of earth dug out, in which the plants are placed in rather a flanting direction lengthways of the hedge, as well as againft the upright fide of the furrow or trench, at the diftance of about four or five inches from each other, covering them with a little of the mould or earth that has been turned up on the other fide, and treading it clofely to their roots. The reft of the loofe mould is generally, in this method of planting, afterwards laid clofe to the plants by means of a fpade.

Sometimes they are planted in the middle of the furrow or trench, the earth

being brought clofe to them by the feet, and the raking of it up on each fide. There are feveral other varieties in the modes of planting, but which, as they differ only in the manner of preparing the trench or furrow, and bringing the mould to the roots of the plants, do not require to be particularly defcribed.

In the laft method of planting, the young quicks are, in fome places, put into holes made by a kind of dibble; but this is a practice that cannot be recommended, as the roots of the plants are not only too much confined, but the water, efpecially in retentive ftiff foils, is liable to ftagnate in the holes, and prevent them from taking root quickly, by which they are often wholly deftroyed.

The method of planting quick hedges upon the furface of the ground without much elevation, feems moft fuited to the drier kinds of foil, or fuch as would be rendered too dry for their growth by having ditches cut on the fides. But even in this way of proceeding, fome kind of ridge, or elevation, fhould be preferved, that the rain water may not injure the young plants by ftagnating too much about their roots.

In planting the quicks where the ground is raifed, Mr. Billingfley advifes a trench to be cut in the middle of the bank, into which the fets are to be put at the diftances of about three inches from each other, with their heads a little inclining. The roots muft then be covered with a little of the beft mould, and afterwards the whole trench be filled up with rotten dung or compoft, only ftrewing fome more good mould on the furface *. But we are affured on the authority of much experience and obfervation, that it is infinitely better to place them five or fix inches apart; and that it is feldom neceffary to ufe dung or compoft to the roots of them where the foil is tolerably good, and care is taken to apply it well to the roots, as it is apt to breed infects, which are very injurious to the roots of the quicks.

The diftances recommended above may, however, anfwer very well where the plants are fmall, and the fituation expofed; but fix or feven inches is better where the plants are of a good fize, and the fituation not too open. Indeed fome advife them to be planted ftill wider, as nine inches; and on good land, as much as a foot. Thick planting is, however, in general, to be preferred, efpecially in expofed places; as hedges, under fuch circumftances, for the moft part thrive the beft, efpecially for a few years; and they may afterwards be prevented from being liable to choke and deftroy each other by proper thinning. Where fencing wood is not eafily procured, it may alfo fometimes be a good practice to plant the quicks both in the face and top of the bank.

In expofed fituations it will always be neceffary to fhelter and protect the

* View of the Agriculture of Somerfetfhire.

young plants by means of ſome ſort of dead fence, ſuch as dead hedges, high banks, low walls, rails, or belts of planting. Where the firſt is employed, it ſhould be made about four inches diſtant from the outer edges of the bank. The hedges for this purpoſe are moſtly about two feet and half high, and made of wreath, or bruſh-wood, with a ſufficient number of ſtakes. This mode is not only much cheaper than that of poſts and rails, but likewiſe conſiderably better, on account of the ſhelter and warmth which it affords to the young plants.

In cold expoſed ſituations, Mr. Billingſley thinks that *two ſets* of dead fences may ſometimes be required for bringing the quicks to maturity; the expence of which he calculates in this way:—

	£.	s.	d.
Making the bank - - - - -	0	0	9
Quick ſets, eighty in a rope - - - -	0	0	9
Planting and dunging - - - -	0	0	2
Two dead hedges - - - - -	0	2	5
Making two dead fences - - - -	0	0	5
	0	4	6
Weeding plants for three years - - - -	0	0	3
Two additional dead hedges - - - -	0	2	10
	£.0	7	7*

It is obſerved that " one waggon-load of writh will coſt 17*s.* 6*d.* and make about fifteen rope of ſingle hedge. And that the old wood will pay for ſundry repairs of the hedges, ariſing from different accidents†."

In low wet ſituations it would probably be the cheapeſt method to have recourſe to ſhort willow ſtakes, which might be put into the edge of the bank in a ſloping direction outwards, and to be bound together by means of an eddering at the top. In this way the quicks would ſoon be protected by means of a living fence. In the Devonſhire mode of planting on a high bank, ſomething of this ſort is practiſed for protecting the young quicks on each ſide.

High banks are ſometimes raiſed with ſods and earth in expoſed ſituations for the purpoſe of protecting young plants. Where ſtones are plentiful, and the ſods

* The price of hazel coppice-wood and labour being conſiderably advanced, one ſhilling per rope, it is obſerved, muſt now be added to this eſtimate.

† Agricultural Survey of the County of Somerſet.

made on the furface, walls about two feet high are raifed for the fame purpofe. Rails can be ufed where protection from cattle is only required. If belts of planting be had recourfe to with this intention, the moft hardy forts of trees or fhrubs fhould be placed on the outfide, and fuch as grow with more difficulty within them.

Quicks for planting ought, as we have already obferved, to be taken from fuch nurferies as have been made on good foils; and fhould be ftraight in their growth, with clean ftrong *ftems*, and have been twice tranfplanted from the feed bed, being about five years' growth from the haw. This fort of quicks have generally a great number of roots, which, as has been fhewn, renders them more certain of fucceeding on being planted out. It is well obferved by Mr. Middleton, that if quickfets are bought after they are taken up, the purchafers fhould beware that they are not thofe drawn up by the roots on the commons; that is, wild quicks; as they are ftunted plants which canker and never grow well. It is a cuftom with thofe people who live near to, and on the commons, when there is an inclofure, to collect the wild quicks, cut the tops off within only a few inches of the ftems, and fell the roots. They commonly difpofe of them at a much lower price than the nurfery-men, but they will never make a good fence*.

Thefe fences are frequently prevented from fucceeding fo well as they might otherwife do, efpecially where the quicks are young, by the bottoms being neglected and not kept fufficiently clean. They fhould be well weeded and hoed as often as is neceffary, and every fort of rubbifh be carefully removed from about their roots and ftems. This may be performed in the moft eafy and beneficial manner, by firft loofening the earth on the fides of the plants by means of a fort of fpud or three-pronged fork, as the roots are thus not fo liable to be injured, while the weeds are more readily removed. In young hedges, this bufinefs fhould always be done as early as poffible in the fpring, in order that the weeds may be prevented from feeding, as well as getting too great a head. In the cleaning of hedges, when fituated in the banks of ditches, it is a common practice to pare the furface off thinly by a fpade; but which, though it renders it clean for the time, not only expofes the banks more to the mouldering effects of the air and frofts, but in time fo reduces them that the roots of the plants are left expofed, and the ditches fo choaked up as to prevent the water from getting readily away. Where the fhovelings from the ditches in road fides, or other places, are laid up to the roots of the plants, which is often done when they are put in on high banks, great care fhould always be taken to lay them up and fecure them well, by

* General View of the Agriculture of Middlefex.

placing tough fods for them to reft againft; as where they are only bet or plaftered up by the fpade, they are foon apt to crumble and carry down with them large parts of the banks, by which more injury than good is often done.

The cropping of fheep and cattle ought alfo conftantly to be well guarded againft; but where this has happened, the bruifed fhoot fhould always be cut down within an inch or two of the ground. The mould fhould, likewife, be loofened and drawn up a little to the roots of the plants, by which they are made to grow not only more vigoroufly, but to fend out more numerous fhoots.

All the operations for the above purpofes fhould, probably, be performed much more frequently than is the common practice among farmers; or than has been generally fuppofed; as by fuch means the general growth of the hedges will not only be encouraged, but more numerous fhoots be fent off from the bottom ftems, and thus render them thicker.

In regard to the propriety of planting timber trees in hedge-rows, there is fome difference of opinion; we apprehend, however, that it cannot in general be admitted to any very great extent, though it ought not probably to be totally neglected. When planted in this way, the droppings of large trees do not only frequently deftroy the young thorn plants, and thereby caufe holes or vacancies in the hedges, but confiderably injure different forts of crops, efpecially thofe of the corn and grafs kinds.

Where hedge-row planting is, however, wholly difregarded, there is a nakednefs, as well as wildnefs of profpect, which is highly difgufting to the eye of the traveller. Befides, as in this way timber trees are raifed with but little expence, or trouble, there would feem to be confiderable lofs to the proprietors of land, as well as farmers, in not paying fome attention to fuch methods of raifing ufeful and neceffary timber.

When this method is followed, and for planting in the angles, corners, and other wafte fpots of fields, the Scotch fir, the beech, larch, fycamore, and birch, as being hardy trees, are the moft proper. The afh may, likewife, be made ufe of in fome cafes without any inconvenience. It is, however, thought by fome that timber is raifed at a greater expence in this way than any other, when all the injury they do is taken into the account.

The common cuftom of cutting and clipping young thorn and other quick hedges every year, however advantageous it may be confidered in point of the appearance of the fence, is highly prejudicial to the growth of the quicks or other plants, keeping them fmall and weak in the ftems, and rendering the hedges, as they grow old, open at the bottoms. On the contrary, thofe that are left to

themfelves become ftrong in the ftems, and have large fide branches, which, by interweaving with one another, render the hedge thick and impenetrable. Thofe that are cut at proper intervals, as about every feven or eight years, have generally a confiderable fuperiority over thofe which have been clipped from the time they were firft planted. Befides, there is a confiderable faving of labour, and the hedges are far more profitable.

When pruning is neceffary, it may be performed in a neat and expeditious manner, by means of a pair of pruning fhears; the beft fort of which are thofe conftructed with a ftrong fharp blade, about fix or eight inches in length, moving between two pieces of iron, with fquare edges as cheeks. The handles fhould be a good length, in order to give the operator fufficient command in cutting the upper parts of the hedge, and the higher one three or four inches longer than the lower*. Some workmen, however, prefer for this purpofe an inftrument made fomewhat in the form of a reaping-hook, and extremely fharp, to which is fixed a handle of about two feet, or two feet and an half long. In the hands of an expert workman this, too, is a very good implement.

The time at which hedges are ufually cut is the fummer, which, from the ftate of vegetation, is evidently the moft improper that can be chofen, as the plants by being cut, while full of fap or juice, cannot but be greatly injured. The moft fuitable period for this bufinefs would feem to be that of the latter part of autumn, when the growth of the plants is in a declining, or the leaft vigorous ftate.

In refpect to the manner of cutting them, various methods are adopted and practifed, but that which feems to give them the moft ufeful form, is by letting them have a kind of floping or narrowing direction on both fides from the bottom to the top, as by fuch a mode the thickeft part will be in the bottom where it is the moft wanted. The reverfe of this is, however, frequently the cafe in cut or clipped hedges.

The bufinefs of clipping or pruning hedges fhould not, as has been juft obferved, be performed too frequently, as by fuch means they are liable to become thin in the bottoms, a defect which can only be effectually removed by cutting the plants down clofe to the ground. For feveral years after a hedge has been planted it fhould, therefore, probably undergo little cutting, except in the lateral branches that may fpread out; in the taking off of which, attention fhould always be had to draw it to a ridge-like form, or make it the narroweft at the top, as has been fuggefted above.

On thefe points it has been remarked, by a very able and experienced writer,

* General View of the Agriculture of Northumberland.

that " nothing can be more prejudicial to a young hedge than an injudicious application of the fciffars ; and that although it be extremely common to clip the top of a hedge for a few years at firft, even where it is to be difcontinued ever afterwards, yet it would hardly be poffible," he thinks, " to contrive a practice that would be more prejudicial to it than this is. The chief properties that conftitute the excellence of a hedge, are ftrength and clofenefs. Now," fays he, " a hedge can be made ftrong by nothing elfe than the vigour and fize of the principal ftems of which it is compofed. But it is evident that, by cutting the tops of all the radical fhoots, each of them is forced to fend out a great many fmaller ones, as in a pollard-tree ; and each of thefe fmall ftems being cut again and again, are divided into ftill fmaller and more numerous ramifications, till their number is increafed to fuch a degree, and their fize, of confequence, fo much diminifhed, that the hedge may be faid to confift entirely of an infinite number of fmall twigs clofely interwoven with one another, which have not fufficient ftrength to make any confiderable refiftance to a furious bull, or other ftrong animal, who will eafily break through any part of fuch a hedge that he may chance to attack, however clofe it may appear to be. But if, inftead of being cut on the top, the thorn be allowed to advance upwards without any interruption, its ftem, like that of any other tree, will continue to increafe in fize and ftrength, and, in a fhort time, become fo large as to be able to refift the whole force of any animal that we may have occafion to fear. They even in time become fo large, as to occupy almoft the whole fpace that was originally left between the plants, fo as to form," he fays, " a folid vegetable wall (if he may ufe that expreffion), which it is almoft impoffible for any force to overturn. It is therefore obvious," he thinks, " that cutting the top of a hedge when young, tends greatly to diminifh the ftrength of it*."

He further obferves, that it will, perhaps, be a more difficult tafk to convince the reader, that this practice likewife tends to diminifh the thicknefs of the hedge ; although he flatters himfelf that he fhall be able to demonftrate this as clearly as the other. " When," fays he, " the principal ftem of any tree is cut over, the fap that would have gone to increafe the fize of its top, being ftopt in its afcent, forces out a great many fhoots all round the ftem, immediately below the place where it has been cut over. And when this is the cafe with a hedge, the number of fhoots that are crowded together, draw the fap fo powerfully to that place, and occafion fuch a deep fhade below it, that all the horizontal fhoots

* Anderfon's Effays, vol. I.

which had fprung out from the ftem, near the roots, being deprived of their nourifhment, and the influences of the air, are checked in their growth, and in a fhort time totally perifh, leaving the ftem at the root quite naked and bare. And as there are from that period no branches fpringing immediately from the under-part of the ftem to detain the fap in its paffage, and make that part of it increafe in fize, it there continues fmall and weakly; while the top, continuing to advance with luxuriance, becomes fo large and weighty, as to be with difficulty fupported by thefe fmall naked fhanks, which gradually become barer and barer every year. But every one knows," he fays, " that if the bottom of a hedge be open, it is of very little confequence whether it be clofe above or not: and he leaves it to be determined by experience, whether this is not, in general, the condition of hedges which have been clipped in the top when young, efpecially in thofe cafes where the hedge has made vigorous fhoots the firft year. And if it fhall be found that this is in general the cafe, we muft conclude," he thinks, " that the practice here reprehended tends to make the hedge thinner, as well as weaker, than it would have been if that operation had been entirely omitted. But if an hedge is allowed to advance in height, without being cut in the top, the fmall branches that fpring out near the root, not being ftarved by the extraordinary fuction, or fuffocated by the fhade of too luxuriant branches above them, continue to live, and detain a part of the fap, fo as to make the under part of the ftem ftill continue to increafe in fize and ftrength, and be well able to fupport the fmall top that it thus acquires. And if the moft luxuriant fide-branches that may fpring out above, are from time to time pruned away, fo as not to be allowed to overfhade thofe that may be below, thefe laft will continue to grow as long as the hedge exifts. And as, by this management, there will be but few fide branches of any confiderable fize, the principal ftems will advance with very great vigour, gradually tapering from the root upwards. He cannot," he thinks, " be too particular in advifing the hufbandman to beftow his attention chiefly to the proper formation of the upright ftems of the hedge, becaufe upon this the whole future ftrength of the hedge muft," he fuppofes, " entirely depend: and if thefe are once rightly formed, it will be an eafy matter to give it every quality that we could wifh for in a hedge. For, if thefe ftrong ftems fhould be even entirely deftitute of fmall branches, abundance of them may be made to pufh out whenever it fhall be thought neceffary, by only making a flight wound in the naked ftem, wherever you defire that young branches fhould appear: for, below every fuch wound, a number of fmall fhoots will fpring forth the enfuing feafon; the points of which being cut off, a ftill greater num-

ber of small twigs will be sent out, which, by being frequently cut, will, in a short time, form a covering as close as could be desired. The truth of this reasoning," he says, " he experienced at a very early period of his life; for, having then had occasion to dress a garden that was surrounded by an old hedge, which had always been allowed to grow as nature prompted, never seemingly having been touched either by knife or scissars, he found the branches straggling very far on every side; all of which," he says, " he caused to be cut off quite close by the upright stems, which then were left entirely naked, and appeared like as many may-poles placed beside one another. But by cutting a good many slight notches all along these stems, at the distance of a few inches from one another, they were in one year entirely covered with young shoots; which small branches, by being cut once or twice in one season, put out such a number of smaller ramifications, as in a short time formed a covering so very close, that it was hardly possible to see an object through it in any part. Nor did he ever in his life see a hedge that, either for strength or beauty, could be compared with this one. Many of the stems were six or eight inches in diameter; and they grew so close to one another, that no animal larger than a small bird could possibly have penetrated it.

" From these observations," he thinks, " it will appear evident, that if we wish to have a good hedge, either in respect of strength or closeness, it is of importance never to shorten the top shoots, at least while it is young; but it is always of use to prune the sides, cutting off all the lateral shoots with the scissars quite close to the upright stems, after the first year's growth. And if, after the growth of the second year, it should happen that too many shoots have sprung out at the top of the first year's shoots (which very frequently is the case), these supernumeraries should be cautiously pruned away with a knife; taking out all the strong upright-growing branches, excepting one for a stem; being always particularly careful to cut them away quite close to the stem from which they spring: for if this caution were," he says, " neglected, a greater number of shoots would spring out from the wound, and the malady be increased rather than diminished*."

These circumstances being properly attended to, the hedge will, it is conceived, need no farther care afterwards, but to be defended from cattle, kept free of weeds, and clipped in the sides once a-year for some time; care being always taken at each clipping to go as close to the last as can easily be done, especially towards the upper parts of the hedge; but towards the bottom, the shoots may be allowed to remain gradually a little longer, so as to make the side

* Anderson's Essays, vol. I.

of the hedge to flope inwards a little above, which gives to the under-twigs a frefhnefs they could not otherwife be made to attain. In firft performing this operation, particular attention fhould be paid to clip it as near to the upright ftems as poffible; for, as the fide branches muft always extend a little farther at every cutting, if this caution be neglected the lateral fhanks will, in time, become naked, and difagreeable voids of courfe formed in the furface of the hedge.

By attending to thefe rules for a few years, he fuppofes the hedge, while it advances in height, will become as clofe in the fides as could be wifhed for; and that although the clipping of the fides fhould be difcontinued after a fhort time, it will be in no danger of running into great diforder; for, as the vigour of the fide fhoots will have been much diminifhed by having been fo frequently divided, none of them will afterwards advance to fuch a diftance as to deform or hurt the hedge; fo that, he thinks, the operation may be difcontinued, unlefs in cafes where great neatnefs is wanted.

In comparing quickfet hedges with walled fences, Mr. Billingfley remarks, that "they are beautiful to the eye, and that if the climate, quality, and depth of foil, be fuch as to throw out a vigorous fhoot, and minute attention be paid to them in their infancy, they are lefs expenfive, and at the end of fourteen years will yield a fufficient produce when cut down and plafhed to pay all the expences incurred in the firft making; and that this cutting may be repeated every twelve or fourteen years without injury to the ftocks*."

He alfo judicioufly reminds the farmer, that the proper time for plafhing his hedges is when the land is to be ploughed, or, if it be pafture, when the crop is to ftand for hay. By taking advantage of the ground being in thefe fituations, the mifchief produced by cattle will be perfectly provided againft.

In the management of old hedges, feveral different methods are employed. Where they become much ftinted, from the badnefs of the foil in which they are planted, or other fimilar caufes, the moft ready and effectual mode of recovering them is probably to cut the plants of which they are compofed down pretty clofe to the furface of the ground in the latter end of autumn, or the early part of the fpring; afterwards keeping them perfectly free from weeds, and managing them in the way that has been directed above. And in the fpring, when the young buds begin to appear, it is advifed, by an experienced writer, to attend carefully to the ftumps, in order to rub off all the buds, ex-

* Agricultural Report of the County of Somerfet.

cept one or two of the ftrongeft, which are beft placed for fhoots; as where the whole number are fuffered to remain and grow, they foon become weak and reftricted in their growth, as in the former cafe. For want of due attention to this, hedges that have been feveral times cut over, are frequently quite fpoiled. Where the fields on the fides of hedges, treated in this way, are in a ftate of tillage, they are likewife conftantly found to thrive better than where that is not the cafe, efpecially if they have been planted on the plain furface, or only on a flight bank *.

In other inftances, hedges, when they have had about eight or ten years' growth, are headed down to the height of two or three feet. This is, however, by no means a good practice, as in confequence of the young fhoots fpringing from the tops of the ftems, the lower parts of the hedge in a few years not only become thin, bare, and full of openings, many of the ftems being dead, but from their fhooting out fo bufhy at the top, they are apt to fmother all below. After the hedge has a fecond time grown large, the fhoots that fpring from the tops of the old ftems are, however, again fubjected to the axe, a few being left merely for the purpofe of nicking or laying down even with the top of the hedge. Such a fence as this never looks well, nor is it fufficient, without dead wood being put in the bottom, to prevent fheep from running through it, by which all the young fhoots are either broken down or killed.

Another method which is practifed by fome farmers, and which is undoubtedly better than that which we have juft defcribed, is that of laying the hedges. This is, however, a mode chiefly employed when they are not very old, but thin and full of gaps or fpaces, where there are no plants, and is done by cutting off the ftems of the quicks clofe to the ground, leaving only one in the fpace of about every foot, which is trimmed nearly to the top, nicked, and then laid down and interwoven in an horizontal pofition, either with fuch living ftakes as may have been left, or dead ones fet into the ground at about the diftance of a foot and half from each other. The top of the hedge is afterwards bound with ftraight branches of hazel, or other fmall wood, twifted together in fuch a way as to inclofe each ftake, by which means they are fupported, and the layers kept in their proper fituation. From the tops of the ftems which have been thus cut, and thofe which are nicked, in a couple of years an abundance of young fhoots arife, by which an excellent thick hedge is formed. In per-

* Anderfon's Effays, vol. I.

forming this bufinefs the operator fhould, however, be careful to fill up the places very well where the hollows or void fpaces formerly were, by laying them more clofely down, and putting in proper ftakes. In making this fort of hedges the perfons employed begin at one end, and proceed regularly forward till the whole is laid down to the proper height, which, by a good workman, is very readily accomplifhed. In fuitable fituations, ftakes of willow or alder may be employed with advantage, as they frequently take root and grow well. This is an extremely good method of renewing an old hedge under fuch circumftances. The principal objection to the above plan is, that in the courfe of a few years the layers, efpecially if they be thick or ftrong ones, die, and the young wood underneath is much checked and injured in its growth, by the droppings from them and the decayed bindings.

But the beft, and probably the moft advantageous method of renewing an old hedge for the farmer, particularly where it can be protected from cattle, is that of heading the whole down to within a few inches of the ground or bank. By this means in a couple of years an aftonifhing quantity of young wood is produced, fo as to form a hedge that can fcarcely be feen through. Where there are ditches, the fcourings may be thrown up to the roots, which ferve as a fort of earthing up to the plants, and make them grow with greater vigour and ftrength. By this method, however, if the hedge be old, many of the larger thorns will frequently die. In laying the earth up to the roots great care fhould be taken, as injury is often done by overloading them, whole fences being fometimes deftroyed in that way. Where, however, the plants are cut clofe down, and fuitable earth applied over them, a great number of vigorous fhoots are not only fent out from each ftem, but from their being in the ground frequently take root, and become independent plants, by which the bottom parts of the hedges become extremely thick and clofe. A flight ftake and edder fence muft be made in order to preferve the fhoots from being cropped and deftroyed. Part of the wood which has been cut out of the hedge ferves for this purpofe ; the remainder being either employed in making of other fences, or made into bavins for the ufe of bakers, &c. * by which a confiderable profit is immediately produced. By this method too, where there are ditches, the fides of the banks are much preferved from being deftroyed by cattle, as the plants fhoot out both on the fides and the tops of them.

This feems, therefore, to be a much better practice than that of making a

* In London thefe bavins generally fell at about a guinea a hundred, delivered.

folid face to the bank, by means of either fods or ftones, as the young wood is not prevented from growing on the fides of the banks, or the banks fo liable to be thrown down by animals. Befides, there is confiderably more produce of wood from the hedge, which in many fituations is an object of great importance. Where hedges grow thin at the bottom, Mr. Harper, an ingenious Lancafhire farmer, was accuftomed to follow this practice: " He cut the wood very low, leaving the young and vigorous fhoots; after cutting away the old wood, he took a hand-faw, and cut away again that part of the old ftump, fo far as was fhaken by the hatchet in the firft feparation, and few the top level, fo that the water might not remain upon it. By this practice," he fays," the fhoots will grow ftronger, and more in number, in one year, than they would by the common practice in three years. When the fhoots are half a yard, or two feet long, he bends the young fhoots down, and, where room permits, makes a hole in the bank with a fhovel, in which the fhoots are clofely tied down with hooked fticks, and covered up again with earth, when thefe young branches, with a little nurfing, will, by taking root afrefh, form a new hedge*." But from the great trouble and confequent expence of this method, it can probably only be had recourfe to in particular inftances. There can, however, be no doubt but that the lefs injury there is done in the cutting of the plants, the better they will throw out young fhoots, and alfo the lefs liable they will be to decay from the ftagnation of moifture upon them.

It has been fuggefted by fome planters, that quick hedges may much more readily be raifed by the warmth and fhelter of low ftone walls; they have therefore propofed the making of both a wall and a hedge; to which there can certainly be only one material objection, which is that of the expence. Where there are plenty of ftones, and the fituation is elevated, cold, and expofed, fuch a plan may be deferving of attention.

The wall in thefe cafes fhould be about four feet and an half high, and be turfed on the top; the quicks being planted on a low bank raifed under it, and a dead fence made on the infide, in order to afford them protection †. After the quicks

* Agricultural Survey of the County of Lancafter.

† The expences of this as ftated by Mr. Billingfley, in the Agricultural Report of the County of Somerfet, ftand thus:

	£.	s.	d.
Building four feet and a half of wall, ftones and halling included	0	6	0
Turfing - - - - -	0	0	2
Making bank and planting quick - - -	0	0	4
Carried forward, -	0	6	6

are grown up, the wall may be pulled down, and the materials be converted to other ufes.

There is another mode of fencing, which is fometimes adopted in expofed fituations, where the foil is fufficiently good, which is that of planting full-grown floe, or black-thorn, pretty thick, and mixing with them hazel, withey, the large briar, &c. cutting off their tops to the height of about three feet, on a bank raifed from two to three feet, with ditches fufficiently deep. This is not, however, a method to be recommended, except in fuch kinds of bleak fituations. The black-thorn abounds in moft places, and may therefore be eafily procured. The loppings of the plants may be ftuck along the fide of the bank, being well fecured by fuitable ftakes, fo as to guard the ftocks from being injured by cattle or fheep. This fort of fence is made at an extremely cheap rate, from the low price of the plants; and from their throwing out fhoots very extenfively, with the affiftance of the briar, in fuch fituations, fometimes foon form a clofe and impervious hedge.

In this way this fort of thorn does not, indeed, grow to any great height, but fufficient with the bank for the purpofes of confining and fheltering animals. If the fields be in a ftate of arable cultivation, the ditches, when made of a good depth, will prevent the running of the roots from obftructing the plough * †.

	£.	s.	d.
Brought forward, -	0	6	6
Sets - - - - - -	0	0	8
One dead fence on the infide - - -	0	1	2
Weeding - - - - -	0	0	2
	0	8	6
From which deduct the value of the ftones, at three pence per cart-load	0	1	6
	0	7	0

* Agricultural Report of the County of Somerfet.

† One good waggon-load of thefe plants, it is obferved in the fame work, will be fufficient for twelve rope. The coft is thus eftimated:

	£.	s.	d.	
Making the bank - - - -	0	1	0	per rope.
Digging up and planting - - - -	0	1	6	
Carriage of plants - - - - -	0	0	9	
	0	3	3	

In refpect to the carriage, the price muft vary according to the diftance, and other circumftances.

Where land is much expofed to the fea air, it is found extremely difficult to raife quick fences upon it as this air; probably from the fuperabundant quantity of muriatic acid which it conveys, and which is readily feparated from it, on account of its loofe ftate of combination, is highly deftructive to the white-thorn, and feveral other plants employed in the making of hedges. The beft mode in fuch fituations is probably that of planting beech, as it feems, in a great meafure, proof againft the injurious operation of this kind of air. The bank on which it is to be planted fhould be fix or feven feet high, and four or five in width at the top; on which the young beech plants are to be put in, in two or three rows, at about the diftance of a foot from each other, and fufficiently thick in the rows. In moft cafes no ditch is made; but in fome inftances the banks, or mounds, are prevented from crumbling down either by a low ftone wall, or fome other fuitable means. The growth of thefe plants is rapid, they therefore foon form not merely an excellent and beautiful fence, but one that is highly advantageous both in refpect to the fhelter which it affords, from the leaves being retained to a late period, and the annual profit that may be derived from it; as when at maturity one of the rows may be alternately cut and converted to various ufes, and the others plafhed or trimmed fo as to yield much wood for fuel or other purpofes. This fort of hedge has, however, one great difadvantage, which is that of requiring fo large a quantity of earth for the making of the bank.

In fituations fuch as the above, furze may often be made ufe of for a fence, as the young furze grows quickly, and without much difficulty, if they be raifed by fowing the feeds thickly upon pretty high and broad banks, with ditches on the fides. As the old parts of furze foon die away, it will always be neceffary to guard againft the thinnefs produced in this way, which may probably be beft done by cutting the plants clofe down firft on one fide, and then on the other, every two or three years, to admit of which is the principal defign of fuch a broad bank; and thus have a fence on one fide or the other conftantly in perfection. The cuttings obtained in this manner may in fituations where fodder is fcarce be made ufe of, when bruifed, as an article of food for animals. This mode of training furze fences is, however, objectionable, not only as wafting a great deal of ground, but as being liable, from the feeds being fcattered over the inclofures by the wind, to fill them full of this almoft eradicable plant.

In planting hedges of willow and other aquatic plants, the ground fhould always be made as mellow and friable as poffible, and the fhoots to be em-

ployed of two or three years' growth, and frefh cut off at the time of ufing them. They are then to be put into a narrow ridge of ground, prepared for them, at the diftance of eight or ten inches from each other, the tops being bent different ways, and plaited firmly together fo as to make a fence *. The grey willow is probably the beft kind for this purpofe. In fome inftances the fweet-briar may probably be mixed with the willow to advantage.

Whatever fort of fence is made in fuch fituations, it is perhaps a good practice to raife a pretty high bank with a ditch on each fide, and in fome cafes to plant hedges in each face of the bank, fo that it may afford fhelter to them while they get up, and that afterwards one may protect the other, and render their growth more rapid.

The filling up the deficiency of hedges, of whatever kind they may be, with dead materials, though a very common practice, fhould be had recourfe to as feldom as poffible, as the hedges are by this means not only prevented from throwing out young fhoots to fill themfelves up, but the dead materials when they begin to decay leave larger openings than exifted before they were introduced. Where hedges are difpofed to become moffy, the mixing of lime, afhes, or fuch-like fubftances, with the mould of the banks, may frequently be of confiderable utility in removing it.

In fome fituations, hedges made folely of dead materials are had recourfe to as a means of dividing inclofures. This is, however, a practice which, from the great expence of forming them, their conftant tendency to decay, and the neceffity they have for annual repairs †, fhould never be adopted when there is a poffibility of raifing living fences, except indeed when they are merely ufed, as has been already noticed, by way of a protection to young quick hedges. For the former purpofe, the longeft part of the cuttings from living fences, or other places, are wattled by means of ftakes driven into the ground at fixteen or eighteen inches diftance from each other, and bound on the top by means of afh, hazel, or willow bindings. This is termed a *ftake* and *band* hedge. With the latter intention, the fhorter and more bufhy fort of cuttings are generally employed, and either ftuck into the ground on the furface, the fide or top of the bank in a flanting direction lengthways of the fence, and inclining a little towards the inclofure, or made into a low ftake and band hedge, in the way defcribed above. In making this fort of fence, great care fhould be taken not to

* Anderfon's Effays, vol. I.

† Thefe, in fome inftances, amount to from a fixth to an eighth or tenth part of the rent.

place the dead materials too near the living plants, as by fuch inattention they are frequently much injured and retarded in their growth, from the falling down of the rotten and decayed parts of the wood.

DITCHES.

These are conftructed with different intentions, being fometimes formed only as a part of a fence, or as a drain, while at others they ferve equally the purpofes of drainage and inclofure. But for whatever purpofes they are defigned, they fhould always be formed with floping fides, as when they are cut perpendicularly down, the furface of the land, or the fides, is liable to give way and fill them up. In forming ditches, regard is likewife neceffary to the peculiarity of the foils, and the nature of their drainage, in order that they may be dug in a fuitable manner in refpect to depth, and the direction moft convenient for conveying away the water; much mifchief being frequently occafioned by its remaining in a ftagnant ftate in them, from thefe circumftances not being properly attended to.

When ditches are made for the purpofe of fences, they fhould be fufficiently wide to prevent animals from getting over them, and be more than ufual floped in the banks, that cattle may not fo readily poach them in. In general, from feven or eight to ten feet in width, and from three to five feet in depth, conftitute a pretty fecure fence. Ditches of this fort ought alfo to be more frequently cleaned out, and have their fides well pared down, than is the general cuftom among farmers; as by thefe means the grounds on each fide, and in the neighbourhood of them, are more effectually drained, and the water rendered much lefs ftagnant and pernicious to the health of the inhabitants of the diftricts in which water ditches abound. The earthy materials obtained by this means may often be converted to a very ufeful compoft manure for various kinds of grafs lands, by being well mixed with a fuitable portion of rotten dung.

Care fhould likewife be taken that they have proper communications, with fuitable outlets, as the brooks or rivers in the vicinity of them, as by a neglect of this much mifchief is frequently produced.

In wet marfhy fituations, large fpaces of ground are frequently left between ditches which act as drains. Under thefe circumftances, perhaps, the beft and moft profitable method that can be adopted, is that of planting them with ofiers,

PLATE XXXIV.

Gates and Stiles.

[*To face Page* 143.]

Fig. 1. A common *ſwing-gate* with ſimple croſs bar or brace.

Fig. 2. The common upright *ſwing-gate*, which is more cloſe than the former.

Fig. 3. An improved upright *ſwing-gate*, which, at the ſame time that it is more cloſe, is likewiſe more ſtrong and ornamental than either of the others.

Fig. 4. Is a *ſwing-gate* on an improved principle: *a* the projection on the fore part of the *bar-tree*, riſing nine inches, on which the lower end of the diagonal bar, paſſing upwards, reſts; *b b* the diagonal bar, through which the three middle horizontal bars paſs; *c c* a perpendicular bar fixed into the uppermoſt bar ſix inches from the inſertion of the diagonal one at *d*, and into the lowermoſt at *e*; *f* the ſpring on the fore-tree, by which it faſtens. This is a ſtrong, uſeful gate.

Fig. 5. A double gate of the ſame ſort; *a a a* three croſs bars; *b* the diagonal bar, as in the former. The objection to this conſtruction is the great number of joints.

Fig. 6. Is a gate moving on the centre with the appearance of two gates. This takes up much room, but is ornamental.

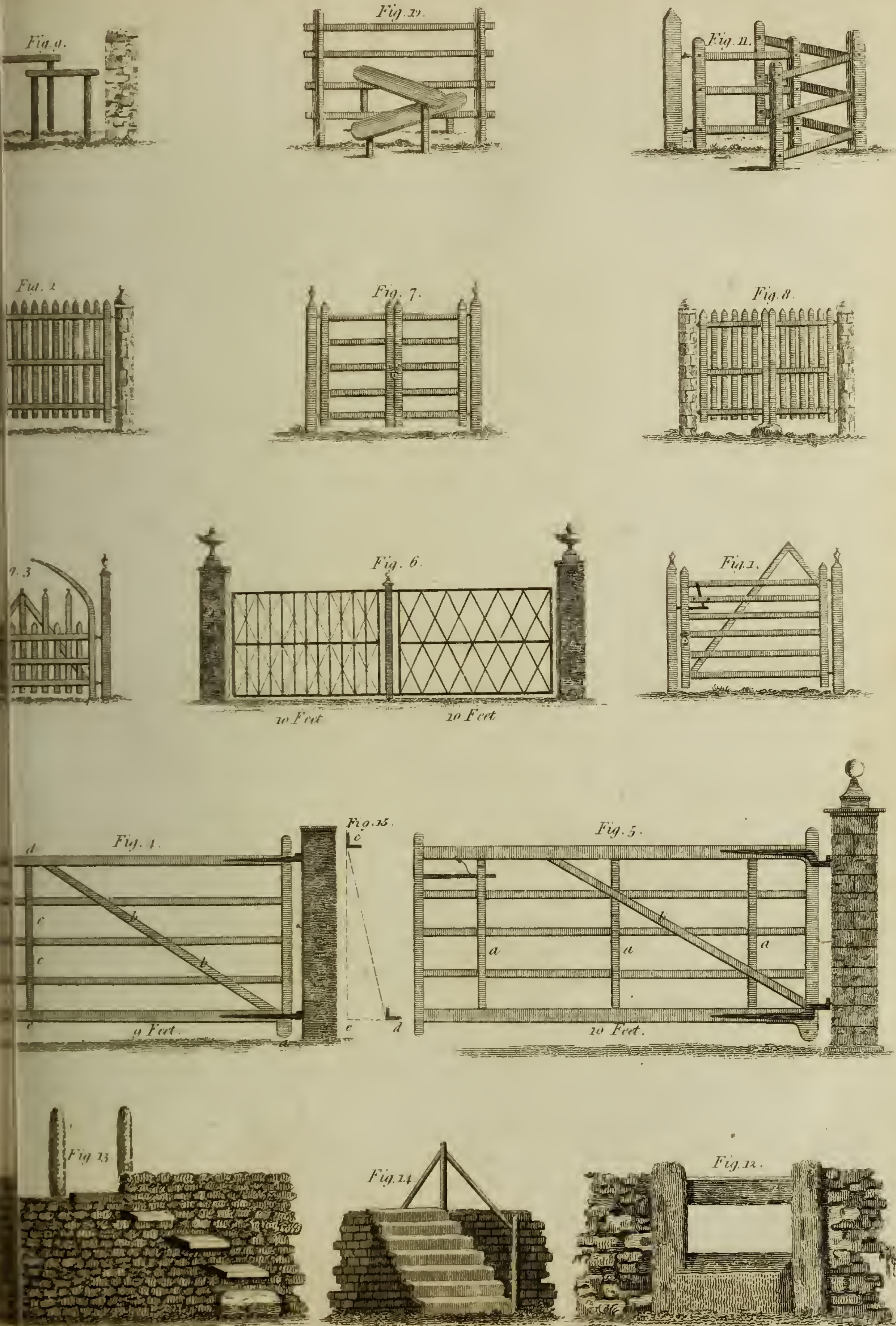
Fig. 7. *Common folding gate*, very uſeful in many caſes.

Fig. 8. A cloſe folding gate.

Fig. 9. Common ſtile. *Fig.* 10. Another common ſtile. *Fig.* 11. The *wicket ſtile*. *Fig.* 12. The ſimple ſtone ſtile. *Fig.* 13. The *Corniſh ſtile*. *Fig.* 14. An improved ſtile with rail.

Fig. 15. Repreſents a ſimple method, deſcribed in the Northumberland Agricultural Report, of fixing the hooks and eyes in hanging-gates ſo as to ſhut in every poſition. The poſts being ſet perpendicular, a plumb-line, *a b*, is to be drawn on it: on this line, at a ſuitable height, place the hook *c*, ſo as to project three inches and a half, and, at a proper diſtance below, put in the hook *d* an inch and a half on one ſide of the line, and ſo as to project two inches; then place the top loop or eye two inches from the *haw tree*, and the bottom loop three inches and a half. For, if the weight of the gate be repreſented by the line *a b*, by the reſolution of forces this is reſolvable into other two *c c*, and *d c*, the former repreſenting that part of the weight which preſſes in a perpendicular poſition, and the latter that which preſſes in a horizontal direction, and gives the gate a tendency to ſhut.

GATES & STILES.



and the bitter willow, as by fuch a plan the farmer reaps advantages in other ways, as well as that of a fence.

Where hedges are made, the ditches, as has been fhewn, are either fingle or double; the latter is more fuitable where much water is to be taken off from the adjoining land; and, in cafes where the earth is well thrown up in the middle, a tolerable temporary fence may be formed.

GATES.

There is much variety in regard to the, materials and the manner in which gates are conftructed, as well as the way in which they are hung; fome confifting of two leaves, others of only one; fome moving on the centre, and appearing like two gates; others turning on one end; fome opening to one fide only, others fwinging both ways by fuitable crooks and eyes. Where oak, afh, or other heavy kinds of wood, are employed for thefe purpofes, the hanging pofts ought to be placed deeper and more firmly into the ground, as the gates made of thefe woods are extremely heavy, and confequently liable to drag the hanging pofts forwards. But they are probably more durable than fuch as are made of the lighter forts of wood.

The Dutch willow, and feveral other of the lighter kinds of wood, may however be converted to the purpofe of making gates, with very great advantage to the farmer, as they may often be cultivated on wafte fpots of the wetter forts of ground, and grow fo rapidly as to be fit for ufe in the courfe of fix or feven years. Gates made from materials of this nature are alfo, on account of their lightnefs, much more durable than is generally fuppofed. But whatever fort of wood is made ufe of in the conftructing of gates, it fhould always be perfectly dry and well feafoned; for if that be not fufficiently attended to, they foon begin to crack and give way when expofed to the weather, efpecially in the fummer feafon.

In the conftruction of the *fwing-gate*, the bars are fo long, that too much weight is often thrown upon the hinges, by whic they are frequently liable to be ftrained or broken; and, unlefs the joints be put together with great correctnefs of workmanfhip, they foon give way.

This, therefore, though an expenfive, is by no means a good form of gate. The *double* or *folding gate*, from the bars being only made about half the length, is found to be more lafting, and not liable to the inconveniences of the above. It, however, requires an additional pair of hinges. The *flip-bar-gate* is a form of gate often ufed, and which, from its cheapnefs and fimplicity, may be very

proper and lasting. It merely consists in having posts fixed up, with mortices cut in them for the bars to be slipt into. However, from its being tedious in being opened, and not being capable of being locked or well secured, it is probably the most suited to the inner inclosures of the farm. The *turn-about* or *wirlout gate* is only necessary where a frequency of passage is required.

A very useful form of gate is described by Mr. Robertson, in his Survey of the County of Perth. " The backof the gate itself," says he," (independent of the post on which it hangs), has a projection of three inches in the timber on the fore side, rising nine inches from the foot of the moveable part. On this projection rests the back end of the diagonal bar, which points upwards to the fore part of the gate, and reaches about four feet and a half in that direction. This diagonal bar is of such a thickness, that every one of the horizontal bars pass through it, nicely mortised, except the lowest and the highest. About six or ten inches from the termination of the diagonal bar above, there is a perpendicular one fixed in the two outside ones above and below, and of such a thickness as to admit all the rest to pass through it, mortised as they are in the diagonal bar. The rest of the gate is made in the ordinary way, and may be of any length. Some of them are," he says, " made double, having more than one perpendicular bar: but these appear to be too complex, and to have too many joints. The excellence of this gate is, that all the horizontal bars, except the highest and lowest, rest, not on the posts only, but likewise on the diagonal and perpendicular bars; and that the diagonal bar itself rests on the projection of solid wood, at the foot of the back post; so that it is impossible the joints can start or the gate come asunder, until the timber rot; or that the gate itself can fall forward, unless the pivot, on which it moves, or the pillar on which it hangs, be faulty. It is far superior to any gate whose diagonal bar is fixed only by nails to the horizontal ones."

For the uses of the farmer, those with five bars, properly braced, are probably the best. They should be about eight feet and a half or nine feet in width, and from four and a half to five feet in height. The bars ought to be made strong, having the depth of three inches and a half. In many cases it is of great advantage to have an iron, or small wooden bar, placed between the two lowermost bars of the gate, as by that means small animals are prevented from getting through at the bottom. The lighter gates can be made in the fore parts, the better they answer, provided they have only sufficient strength to resist the force that may come against them. Where horses are kept,

the top bars of gates fhould, however, be conftantly made confiderably ftronger than the reft, as they are extremely liable to be broken by their rubbing their necks upon them.

Gatepofts, where they can be had, are beft of ftone; but where wood is employed for the purpofe, it fhould be fufficiently ftrong, and fet a great depth into the ground, being previoufly prepared by tar or oil-paint in that part.

The hanging of gates is likewife a point that ought to be attended to, as they are foon deftroyed when they are fixed in fuch a manner as either to drag upon the ground, or go with too much velocity in fhutting. The proper inclination or tendency to fhut of themfelves may be eafily given them by attending to the following circumftances. The hanging-poft being fet perpendicularly in the ground, a plumb-line muft be drawn upon it, on which, at a proper diftance from the top, put a hook fo that it may project three inches and a half from the face of the poft; and at a fuitable diftance below this, the lower hook muft be inferted an inch and a half to one fide of the perpendicular line, having a projection of two inches from the face of the poft; the top loop is then to be put two inches from the face of the haw-tree, and the bottom loop three inches and a half from it. Gates when thus hung will be found to have fufficient fall in every pofition to fhut without any trouble or inconvenience.

STILES.

Stiles are conftructed in very different forms, according to the nature of the materials, and the fituations or purpofes for which they are intended. Where ftones are in ufe, a thin flat one is fometimes fet on edge at the bottom, to prevent fmall animals getting through, and a longifh crofs one placed at top, to prevent their getting over. Where wood is employed, they may have various forms, according to the ingenuity of the workman.

It is well remarked by an intelligent writer on the fubject of inclofing, that "every gentleman, whofe eftate is not already inclofed, will perhaps find his account in beginning with a furvey and plan, diftinguifhing the different kinds of foil, marking the land fit for tillage, and that which is only fit for grafs, and the plantations diftinct from both. He will thus have the whole under his review at once, and have leifure to examine, to digeft, and to amend his plan, both according to his own judgment, and to hear and weigh the remarks of the

beft improvers in his neighbourhood, who have diftinguifhed themfelves by their tafte and their knowledge in rural affairs. This is the time to correct the general plan, rather than to undo any part after it is executed, which always implies weaknefs, precipitancy, and unneceffary expence. The whole will be divided with propriety and precifion, fo as to render it moft beautiful and moft convenient; and every part will be deftined to its proper ufe. If a houfe," fays he, " is to be fet down upon it, the whole may be made an ornament to the principal refidence, by a judicious difpofition of the plantations, hedges, and farm-houfes. Even the farms fhould be divided in fuch a manner, that the dwelling of each tenant may be as central in his fields, as the fituation of the ground will admit, to faciliate his carriages and attendance. The very fteddings of the different farms ought," he thinks, " to claim attention; and much judgment may be difplayed in their conftruction and relative fituation *."

It is further obferved in the fame work, that " various methods have been adopted in defraying the expence of erecting inclofures in the firft inftance, and of preferving them in proper repair. In place of giving any detail of thefe, let it," fays the writer, " fuffice to mention what appears to be the moft equitable and effectual. If a farm is to be inclofed and fubdivided at the commencement of a leafe, the whole expence of making the fences ought to be laid out by the landlord, who has a permanent intereft in the ground; and in the grofs fum of the rent, an equivalent may be charged for the intereft of the money expended in inclofing. If, on the other hand, a farm is to be inclofed during the currency of a leafe, the proprietor ought," he thinks, " ftill to lay out the money, and a contract be made with the tenant to pay fuch an additional rent in name of intereft, as may be agreed upon betwixt both parties. In the provifion made for maintaining the fences in proper repair, the expence ought always to be mutual and equal on both fides, for very evident reafons, and thefe repairs executed by fkilful labourers, when required by either party, and completed to the fatisfaction of the landlord. Few difputes," he fays, " take place about fences, unlefs the agreement be very bungling; the great bone of contention is, the keeping the fences in order; and it is prefumed that by the provifions pointed out, much contention and many expenfive lawfuits at the end of leafes may be avoided."

There can be little doubt but that, by attending to fuch circumftances, the

* Robertfon's view of the State of Agriculture, in the County of Perth.

proprietors of land may frequently avoid improper plans and modes of managing the inclofures of their eftates, as well as prevent the fences, when once formed, from falling into that ftate of ruin and decay, which is too often the cafe where no fuitable regulations in thefe refpects exift between landlords and tenants. The general bufinefs of inclofing may likewife be rendered more eafy and convenient, and thus afford encouragement to the beft, and probably the only means of introducing the moft improved and advantageous methods of cultivation, and the reception of the greateft poffible produce from the land.

SECTION V.

Conſtruction of Roads.

ROADS—Advantages of, various—Circumſtances to be attended to in the Direction of—Different Forms of, conſidered—The Convex—The Concave—The Varieties of flat Forms—No particular Form ſuitable perhaps for all Situations—Various Circumſtances in regard to Forms ſtated—Some Objections to the convex Form, probably not well founded—Concave Form found advantageous in Leiceſterſhire—Peculiarities in the flat Forms, deſcribed—Objects generally aimed at in all—Beatſon's Theory of Roads—Form of the Baſis or Bottom, of much Importance—Application of certain Principles in Conſtruction of—Different Circumſtances to be attended to in—Various Advantages of ſuch Conſtruction deſcribed—Manner of forming the Drains in—When made on this Plan, Roads need not be ſo wide—Much Land may conſequently be ſaved—The Quantity of eſtimated—Different Soils require a Difference in the Conſtruction of Roads—Methods of making them in ſandy—In clayey—In boggy Soils—On the Sides of Hills—Should be kept from having Water running on them in every Conſtruction—Modes of conſtructing iron or railed Roads—Advantages of—Where moſt uſeful—Communication on parochial Roads—Defects of—Means of improving them—Wheels of particular Forms injurious to Roads—Different Effects of the conical and cylindrical—Latter moſt advantageous—Cummings's Eſtimate of the Difference in the Effects of—Forms of Roads that are the leaſt affected by Wheels in general—Fences on the Sides of Roads—Diſadvantages of them—Circumſtances neceſſary to be attended to in.

IT cannot be doubted but that good and convenient roads are of great uſe and advantage, whether conſidered in an agricultural or commercial point of view; yet the beſt means of forming and preſerving them, ſeem, till lately, to have been but very little examined, or attended to. This will be obvious to every one who enquires into the ſubject, as he may frequently find them laid out in the moſt inconvenient and injudicious lines of direction, and conſtructed with conſiderable diſadvantage in reſpect to materials, and the manner of their application. In marking out and directing new lines of roads, the ſurveyor, or the perſon who has the management, ſhould conſtantly keep in his mind a few

leading principles, by which the business ought always, as much as possible, to be regulated; such as those of fixing on the most level, the shortest, and the cheapest lines: for though they can, perhaps, be but seldom entirely followed, they should be regarded, in every instance, as much as is in the power of the person who marks them out. Where, however, these different advantages can all, or several of them, be united in the formation of a new road, it will certainly be advisable to proceed, without hesitation, in such a line; but where that is impossible, which, as we have just observed, must frequently be the case, that line or direction should be adopted which is the most level, for it is obviously better to go some way about in order to procure a level road, than to go in a straight direction, and have a hilly, uneven one. Small elevations, or ascents, should not, however, be much regarded, as they may often supply materials for the lower hollow parts, by which means the road is not only more conveniently made, but rendered nearly level. It may also sometimes be necessary to pass in the direction of slight hills, with the idea of having a sound, firm bottom, and a road easily made; or to avoid swamps, morasses, and sheets of stagnant water, through which roads are made with great difficulty and much expence. Beside, there are often other advantages in taking such directions; as it can scarcely have escaped observation, that such roads as are formed on a gentle declivity always wear the best, are the cleanest, and kept in repair at the least expence. In all flat countries and level situations, a slight declivity should indeed constantly be given to the roads in their first formation, which can easily be accomplished by those who understand the nature and proper construction of them*.

Where communications are by such means to be formed with distant districts, care should be taken that it pass through such parts or places as may afford the greatest and most permanent advantages, without regarding in an improper degree the interest of individuals.

It is evident, therefore, that as much, in the proper performance of this business, must always depend upon the skill and judgment of the surveyor, he should, invariably, in finally deciding on a line of road, make himself fully acquainted with the nature, circumstances, and situation of the surrounding country, and attentively consider, after repeated examinations, which is, on the whole, the best and most advantageous direction to be fixed upon.

After having deliberately decided in regard to the line of direction, it will be proper, in the next place, to consider of the form most suitable for its construction. On this subject very different opinions are maintained. Some contend that roads should be convex; others that they should be concave; others again

* See Beatson in Communications to the Board of Agriculture, p. 128.

that they ſhould be perfectly flat from one ſide to the other, and in the form of inclined planes longitudinally; and a few, that they ſhould be perfectly flat in every direction. It is probable, however, that no one particular form is calculated to anſwer in, or ſuitable for, every ſituation, but that they ought to be varied according to the particular circumſtances and ſituations of the country through which the road is to paſs. A perſon who has been much engaged in this way aſſures us, that he has been clearly convinced, from very long obſervation and experience, that where roads have been made flat in the middle, with the ſides a little raiſed, ſo as to collect the water to that part, with a proper declivity for it to paſs off longitudinally, they have always worn the leveleſt, and, with proper management, been kept in repair at by much the leaſt expence.

In that part of the country where he reſides, he ſays, a turnpike road was formed upon this principle, about forty years ago, and though in the neighbourhood of a colliery, and, conſequently, many heavy carriages paſſing over it at all times of the year, he believes it will not be too much to ſay that it is the beſt turnpike road in the county, and repaired at the leaſt expence of any, upon which an equal number of heavy carriages paſs.

The convex or rounded form of roads is, notwithſtanding, in general, perhaps, by much the beſt, and certainly the moſt common, but the degrees of convexity are very uncertain and indeterminate, depending for the moſt part on the caprice of the perſon employed in the making of them. In general, however, they are conſiderably too much rounded, ſo as in ſome inſtances to be very inconvenient, and even dangerous to the traveller. The adoption of this rounded mode of making roads, ſeems to have proceeded on the ſuppoſition that water would be more readily conveyed off into the ditches or drains on the ſides. But this is not exactly the fact, for much of the water is obviouſly detained on the ſurfaces of ſuch roads by the tracks, irregularities, and roughneſſes, produced by the impreſſions of the wheels of carts and other ſimilar cauſes, which by thus ſtagnating, and being agitated and wrought up by the frequent paſſing of carriages, and other heavy machines, ſoon renders the roads uneven, full of depreſſions, and almoſt impaſſable. The convex method of conſtructing roads does not, therefore, effectually prevent water from reſting upon their ſurfaces. But, beſides this, there are other diſadvantages attending this form of roads; the unequal preſſure which the wheels of carriages muſt have in ſuch caſes, not only tends very much to break up and deſtroy the roads, but, at the ſame time, renders travelling on them very inconvenient and unpleaſant, eſpecially where the convexity is great.

With the mode of forming and conſtructing theſe kinds of roads in the firſt in-

ſtance, a late writer alſo finds great fault, conceiving it highly diſadvantageous and abſurd. The improprieties complained of in the methods of preparing ſuch roads for the reception of the hard and more ſolid parts of the materials, are repreſented in the ſection of a road ſo formed, which may be ſeen in the annexed plate. When thus prepared and made up, it is ſuppoſed, that though it may be imagined that the whole of the water that falls on the road may be conveyed away by the ditches or drains on the ſides, yet if it be examined in a wet ſeaſon it will, it is aſſerted, be found that, in general, however great the convexity may be, the water will ſtand, as has been obſerved above, in the various ruts and depreſſions that may have been made on it, particularly where the road has been ſo long made uſe of, as to have worn down and reduced the ſtony materials on the ſurface, and forced up the moiſt earthy ſubſtance through them; and that if the road has been recently made or repaired, and the materials are of ſo porous a nature as to let the water paſs through them, it will then lodge in the hollows on the convex retentive ſtratum below the hard materials, eſpecially at the ſides, when obſtructed by the footways, by which the bed or foundation of the road is kept conſtantly wet, and thereby quickly becomes out of order. By this conſtant ſtagnation of water below, too, the hard materials ſink down into the ſoft earthy bed below, which works up through them, and cauſes all the dirtineſs obſervable on the ſurface of them in bad weather, notwithſtanding the thickneſs of the covering of hard materials may, at firſt, have been ten or twelve inches. Even where under-drains are formed for taking off the water below the footways, at very ſhort diſtances, this is not, it is thought, prevented, as the intermediate ſpaces quickly become ſo impervious, that the moiſture does not paſs through them to ſuch drains; but the wet earth below is converted into a kind of *puddle*, ſimilar to that made uſe of in preventing the entrance of water in different ground works, by which it is forced up, and ſtands in the depreſſions on the ſurface. But there is, it is ſaid, another method of forming this kind of roads which has been lately deſcribed* and recommended, in which it is propoſed to leave a hollow, or vacuum as it is termed, in the middle, in which the ſolid materials are to be placed, and which is ſhewn in the annexed plate. The ſole difference between this, and that which has been mentioned above, ſeems, it is ſaid, to be, that inſtead of the bottom of the hollow being made convex, it is formed more flat and deeper. It is therefore ſuppoſed that it is liable to the

* Agricultural Survey of the County of Bedford.

ſame objections that have been made to the firſt in a ſtronger degree; and beſides that it requires a greater thickneſs of hard expenſive materials, which muſt be of the greateſt depth in the middle, or part where the ſlighteſt impreſſions are made, and the leaſt injury done by the wheels of carriages or other cauſes *.

The objections, eſpecially to the firſt form, when fully conſidered, will not, however, probably be found to be either ſo forcible or ſo generally applicable as the author ſeems to ſuppoſe them; as it is eaſy to perceive that the convex or rounded baſis on which the hard materials reſt, may, in a great number of caſes, be highly porous, and capable of admitting the water that may come upon it from the ſurface of the road, through the ſtony or gravelly materials, to percolate and paſs through it to the drains which are prepared for taking it away, or even, in ſome inſtances, it may ſink quite down into the looſe porous bed itſelf, and in this way keep the road perfectly dry. It is, therefore, only where the baſis or foundation of the road, on which the hard materials are to be depoſited, whether it be of a convex or hollow form, is compoſed of a retentive or impervious material, ſuch as clay, that ſuch objections can have any weight; and even in ſuch caſes, the ingenuity of expert road-makers frequently prevents the injurious effects that are apprehended from taking place, by providing a *ſubſtratum* of ſome ſort of porous or penetrable materials, for placing the ſtone, gravel, or other hard ſubſtances, upon, that may be employed in forming the upper part of the road. If the looſe penetrable ſubſtances made uſe of in this way be laid of a ſufficient thickneſs, and in a proper form in reſpect to the drains, there can be little doubt but that roads, even when formed in a retentive ſoil, may be kept perfectly dry, and free from the ſtagnation of moiſture below them. Looſe ſand, the ſcrapings of old roads, and many other ſubſtances that can, in many ſituations, be procured in large quantities and with great facility, may be uſed with ſucceſs for the purpoſe.

Concave roads are formed in an exactly oppoſite manner to thoſe of the rounded or convex kind, having the greateſt depreſſion and flatneſs in the middle, where they are the higheſt and moſt round. The ſides of theſe roads are generally made with a ſmall inclination, while the middle part is formed either quite flat, or with a very ſlight degree of concavity, and a ſmall deſcent forwards is given them where neceſſary, in order to carry off the water to outlets conſtructed for the purpoſe. This ſort of fall is formed at a trifling expence by raiſing ſome parts,

* Beatſon in Communications to the Board of Agriculture, vol. I. p. 132.

and lowering others. A ſpirit-level ſhould be employed in the buſineſs when neceſſary, and where the fall is gentle, the inclined plane can ſcarcely be too long*.

In moſt ſituations too, to make theſe roads ſound, a good ditch muſt be made on each ſide, a foot or more deeper than the middle of them; and it adds to their ſafety if theſe ditches be made on the field ſide of the roads; or, where they are ſufficiently wide, firm earthy ribs, three feet in height, may be left on the ſides of the ditches. The leading conſideration in conſtructing roads in this way, is that wherever water flows upon a road, that part of it, if the bottom be ſound, is, it is ſaid, for the moſt part, found the firmeſt, and leaſt deſtroyed. But roads, made on this plan, ought at firſt to be well ſet out and formed, and have the materials laid on true. All ſprings and dribblings of water ſhould, likewiſe, be effectually cut off and prevented from running on them; for if theſe circumſtances be not cloſely attended to, they ſeldom anſwer well.

The advantages attending this form of road are ſtated to be theſe, that there are three parts on which carriages may be driven, without having any improper inclination, or undue preſſure on any of their wheels, by which means the draught is more eaſy to the horſes, while the roads are more equally worn, and, in conſequence of that, much leſs injury done to them.

Beſides, they do not tear ſo much it is ſuppoſed by heavy rains, and are kept in repair with much greater eaſe. In ſome inſtances, too, the waſhings of ſuch roads may, it is conceived, be uſefully turned upon graſs lands.

However much this form of road may vary from thoſe which are in general uſe, it has been contended for by ſome very intelligent advocates, as the late Mr. Bakewell, and Mr. Wilkes; and different roads in Leiceſterſhire have been formed on the plan, it is aſſerted with great advantage, both in reſpect to the roads themſelves, and the cheapneſs of their being kept in repair†.

Thoſe who are in favour of *flat roads with longitudinal ſlopes*, in the manner of

* See Communications to the Board of Agriculture, vol. I

† The directions of Mr. Wilkes, as ſtated in an ingenious paper, in the firſt volume of Communications to the Board of Agriculture is, that—

When the fall is one foot in 150 or 200 feet forward, the fall from the ſides towards the middle ought to be 15 inches in 20 feet.

When One foot in 100 to 150, to be 12 inches.

One foot in 40 to 100, to be 10 inches.

One foot in 30 or leſs, to be even the whole breadth.

Where the width of a road is 60 feet:

One foot of fall to each 40 feet in length of the road:

Twenty feet from the ſides towards the middle, to have 9 inches of fall.

The inner 20 feet to be flat.

very acute inclined planes, contend that by being flat and level from fide to fide, the effect or preffure of wheel-carriages muft be more equally exerted, and the friction lefs; while every part of the road may be made ufe of with equal facility and eafe, that of courfe the wear will be more equal, and the road be eafier kept in order, and with a fmaller quantity of materials. To fome it may appear, and probably is, a difficult point, to keep fuch roads fufficiently dry; it has, however, been already noticed that the impreffions caufed by the wheels of carriages detain the water on the rounded or convex roads, and prevent it from paffing off at the fides; it may follow, then, that as this form of road is intended to have in the level parts very gentle flopes, fuch as the fall of one foot in fifty, for the conveying off of the water, thefe ruts or depreffions may ferve as conductors, and thereby promote the paffing off of the water into the lower parts of the flopes, whence it is conveyed away by the fide drains. On this ground, it is fuppofed that this form of road may be kept clean and dry with greater eafe than thofe of the rounded or convex kind.

The laft form of road to be noticed is that which is *quite flat in every direction.*— This is fupported on nearly the fame grounds as the above, only it is contended, that as there are few fituations fo very level for any length that water will not run one way or the other, it is quite ufelefs and unneceffary to be at the trouble of forming flopes or inclined planes, but that fuitable outlets fhould conftantly be provided at every hollow part for taking off and conveying away the water; that fhould the road in any part be perfectly level, fhallow crofs drains, which it is fuppofed will occafion no interruption to carriages, fhould be formed at every fifty or fixty yards, or nearer, if requifite, by which the road may be kept fufficiently dry and in order.

From thefe accounts and details of the different forms of making roads, it is evident that there are two principal objects to be aimed at in the bufinefs: 1ft. That of conftructing them fo as to render them as free of moifture as poffible at all feafons; 2d. That, that kind of conftruction be given them which is moft calculated to leffen the draught at the eafieft expence. Thefe probably embrace all the neceffaries for forming perfect roads, but the difficulty depends on obtaining them in the completeft manner; feveral modes of doing which have been juft defcribed, and may be had recourfe to according to the particular circumftances of the different cafes.

The author of a valuable communication on the fubject of roads*, has propofed a new theory of conftructing them, which, he fays, is founded on nature. It is well known that fome of the *ftrata* that are found in the bowels of the earth

* See Beatfon in Communications to the Board of Agriculture, vol. I.

are of ſo cloſe and denſe a texture, as not to admit moiſture to penetrate them, while others are ſo open and porous that they readily permit water to paſs through them in every direction, until it meets with ſome obſtruction, or finds a channel to convey it off. Among theſe different *ſtrata* there is alſo much difference in reſpect to their denſity and poroſity; and in proportion as they partake more or leſs of theſe qualities, they admit moiſture to tranſude through them with greater or leſs facility. In further illuſtration of his ideas, and in applying theſe principles in the conſtruction of roads, it is obſerved, that, ſuppoſing the ſection of a hill or eminence compoſed of a number of *ſtrata;* if the uppermoſt *ſtratum* or ſurface ſoil be of a porous nature, it is obvious that, any water falling upon it muſt paſs through to the next *ſtratum* underneath, where if it cannot penetrate any further, it muſt glide along the ſurface till it finds an outlet or vent at the bottom of the eminence. If, however, the ſecond ſtratum ſhould be hollow for ſome diſtance, the water will lodge in that hollow, and conſtitute a kind of pool or bog, as is often noticed on the tops of hills; but if in this hollow place there be a communication with the third ſtratum, which is porous, no water will ſtagnate there, but will paſs through and run along the fourth *ſtratum*, which is denſe, until it iſſues at the ſide or bottom of the hill. It is further evident, that if the firſt or uppermoſt *ſtratum* ſhould be of a denſe texture, as clay, any water coming upon it will not only ſtagnate in the large hollows, but in all the ſmaller ones, as well as in the other irregularities and depreſſions that may be on its ſurface. It is therefore clear, it is conceived, that in order to keep the ſurface of ſuch a piece of ground as that deſcribed dry, it is not of much conſequence what ſhape or form the ſurface has, whether it be convex or flat, ſo that there be a communication with an under *ſtratum* ſufficiently porous to carry away the water below: it is, however, of much conſequence that the form of the upper ſurface of that *ſtratum* on which the water is to glide, ſhould be ſmooth and even, in order that it may the more readily paſs off. This will probably be better underſtood by conſulting the ſection to which it relates, in the annexed plate.

The application of this reaſoning, in the formation of roads, is as follows: "Where a new road is to be formed, let it," ſays the author, "be done in the firſt inſtance nearly in the uſual manner, with ſuch materials as are on the ſpot, and the nearer the quality of theſe approaches to clay, ſo much the better. Inſtead, however, of forming it convex, as is generally done, it ſhould be quite ſtraight on each ſide, and meet in an angle or ridge in the middle of the road, having a ſlope from thence to each ſide of about an inch in a foot; and ſmall drains at theſe parts, for the more eaſily conducting away the water that may be collected

at thoſe places. The road being thus formed muſt," he ſays, "be allowed to harden and ſettle for ſome time, before any other materials are laid on; great care muſt be taken, while in that ſtate, to let no carriages or cattle upon it, and it ſhould be rolled with a long wooden roller that will reach at once nearly over one ſide of the road. This roller ſhould be loaded with a box of ſtones to make it ſufficiently heavy, and that it may be the more portable when that box is taken off; and it may be ſo contrived that, by changing the horſes from one ſide to the other, there will be no occaſion to turn the roller, in order to make it roll the ſame ſpace over again. Being rolled in this manner, will conſolidate the materials compoſing the ridge, and prepare it for receiving thoſe to come afterwards; for it is a moſt abſurd practice to lay hard materials in the common way, upon the firſt form or baſis of a road, before it is ſufficiently firm to bear them.

"Being thus formed and properly ſettled, the next ſtep to be taken is,' he thinks, "to imitate the works of nature in dry ſoils as nearly as poſſible, by forming a *ſtratum* penetrable by water, compoſed either of ſand or ſandy gravel, or any other ſubſtance eaſieſt to be got, that is ſufficiently porous to admit water to paſs through it. This *ſtratum* ſhould be laid quite level, and extending from one ſide of the road to the other, filling up alſo the ſmall drains on the ſides (as may be readily ſeen by referring to the annexed plate). Over this are to be laid the beſt materials that can be got for completing the road, conſiſting either of ſtones broken very ſmall, or of the beſt gravel. This coat of hard materials need not," he ſuppoſes, "exceed above ſix or ſeven inches in thickneſs, which being much leſs than is commonly uſed, will be a conſiderable ſaving: and it may even ſtill be leſs," he thinks, "if the directions hereafter given are ſtrictly attended to. If this covering conſiſt of broken ſtones, they ſhould afterwards be laid over with ſand or fine gravel, when eaſily procured, ſo as to fill up all the cavities betwixt them. The ſand or rubbiſh from a free-ſtone quarry is excellent for this purpoſe, provided there is no mixture of earth in it, which ſhould be carefully guarded againſt in every ſtep taken after the road is firſt formed. Theſe finiſhing materials being properly laid on and ſmoothed with a rake, the whole ſhould now," he ſays, "before any carriages or horſes are admitted upon it, be well rolled with a heavy iron roller, divided in three parts," as repreſented in the plate on rollers. The writer alſo ſuggeſts "that it would ſave much expence in repairing roads, eſpecially new ones, if rollers of this kind were more generally employed, as it cannot be ſuppoſed that they will immediately bear wheel carriages, or remain long in repair, when compoſed entirely of looſe materials, unleſs ſome pains be taken to conſolidate them. Rolling would of courſe, it is ſuppoſed, produce the moſt advantageous and uſeful effects, and

tend very greatly to keep the roads in an even ſtate, and free from deep ruts and hollows; and that nothing could conduce more fully or more effectually to produce and preſerve firmneſs, without which it is utterly impoſſible to have good roads."

The advantages of having a road laid out and conſtructed in this way are ſaid by the author to be theſe: "that by having a level ſurface, every part is convenient and ſuitable for carriages, and will, of courſe, be equally made uſe of; from which the deep ruts, ſo common in other roads, will, in a great meaſure, be prevented. It will, on this account alſo, be much eaſier kept in repair; and if well managed at firſt, will be conſtructed at leſs expence than by the common modes of making roads, eſpecially in ſandy ſoils, or where ſand or gravel can be procured with facility. On ſuch a road the draught too will be conſiderably eaſier. It is likewiſe a great advantage in theſe roads, that by having an under *ſtratum* through which water can penetrate, and the ſpaces among the harder materials being filled with the ſame kind of porous material, no water can ever ſtagnate on the ſurface, nor can it ever in wet ſeaſons become ſo dirty as other roads; all the water that falls, except, perhaps, in very heavy rains, being conducted away underneath, as well as in every part." In concluding that, from the interſtices between the different parts of the hard materials being filled up with looſe porous ſubſtances, through which moiſture can readily paſs, roads never become ſo dirty or water ſtagnates ſo much upon them, the author is probably miſtaken; as a very ſhort examination of the matter will clearly ſhew, that whether the covering of roads be of ſand, ſmall ſtones, or gravel, when they become pulveriſed by the wheels of carriages, which they ſoon will be in dry weather, and on wet weather coming on will be waſhed into the various interſtices of the ſtones, or other hard materials, effectually blocking them up, and thus rendering the ſurface completely *puddled,* to uſe a term employed in ground works, and thereby to retain water equally with any clay.

Sometimes it will be requiſite, it is ſuppoſed, to have croſs drains carried under the fences from the ſmall ſide drains mentioned above, at the diſtance of every ten or fifteen yards, where the level of the ground will admit of them.

Theſe may be made of any ſuitable material; if of wood, it is conceived that an inch in the bore will be ſufficient. Such a narrow paſſage muſt, however, be very liable to be choked up and obſtructed; it would, therefore, be much better to have them two or three inches, or of ſuch ſizes as may be ſuited to the quantity of water that may at any time come upon them.

It is to be particularly noticed, that on all ſloping roads on a declivity, where the water is apt in heavy rains to run upon the ſurface or at the ſides, that it ought

never to be ſuffered to paſs in the ſame direction more than ten or fifteen yards, but at ſuch diſtances to be conducted away to the main drains, at the ſides. By this means it will do little harm, as it can never increaſe to more than a weak ſtream ; but if it be permitted to run one or two hundred yards, it will probably be ſwelled to ſuch a ſize before it paſſes off, as to waſh away much of the materials, and do conſiderable damage to the road or fences on the ſides of it*.

When made on this conſtruction, the ingenious author ſuppoſes, that roads need not be quite ſo wide as they are in common, as the whole ſurface of them from ſide to ſide will be in uſe. From twenty to twenty-four feet wide, he thinks, will be ſufficient; except it be in the vicinity of large and populous towns, or near extenſive works where a great number of carts or other carriages are employed, in which ſituations they may with propriety be made much wider, as from thirty to forty, or even fifty feet. In the interior parts of the country, twenty feet in width will, indeed, anſwer every purpoſe. It has been obſerved in many places where the roads have not been more than eighteen or twenty feet wide, and properly made from ſide to ſide, that they were in much better condition than the neighbouring ones, which were from thirty to forty, or fifty feet in width. On theſe wide roads, formed in the common way, there is, it is obſerved, ſeldom more than eight or ten feet in the middle of them generally made; the remainder on each ſide being taken up with heaps of ſtones, ſcrapings, and rubbiſh of other kinds, which, though they may be ſometimes wanted in repairing the roads, ſhould not be ſuffered to remain in ſuch ſituations, as they may be dangerous for horſes and carriages in the dark. Beſides much valuable land is, he thinks, loſt to the community †, and conſiderable injury frequently done to the farmer, by the ſeeds of noxious weeds which are ſuffered to ripen and be diſſeminated from ſuch ſituations.

The difference of ſoils makes conſiderable difference in the conſtruction of roads. Where the ſoil is of the ſandy kind, roads may be made with great facility on the plan juſt deſcribed, as there will be little more to do than level the ſurface properly, fill up the different hollow places, roll it very well with the long

* Beatſon in Communications to the Board of Agriculture, vol. I.

† The mode of calculation by which he attempts to ſhew the quantity of land thus loſt is this: "Suppoſe," ſays he, "the medium neceſſary width of roads to be ſeven yards, or twenty-one feet, and that the medium width now made is eleven yards, or thirty-three feet ; this is, upon that ſuppoſition, four yards wider than is neceſſary, which in every mile is a loſs of one acre one rood and two perches; and ſuppoſing there are 5,000 miles of ſuch roads in the whole kingdom, there is a loſs of more than 6,300 acres, which, if eſtimated the ſame as the improved value of the waſte lands, at 27*s*. per acre, and at thirty years' purchaſe, would produce 255,150*l*.: a ſum which, if laid out in improving the roads and making eaſy communications through different parts of the kingdom would," he thinks, "be of the greateſt public advantage.

wooden roller, and lay on fuch materials as are intended to finifh it with, in the manner that has been already defcribed, and afterwards roll it very well with the heavy iron roller But if the foil confift folely of a deep loofe fand, the beft and eafieft method of making a lafting road, is to conftruct it to the intended width for the hard materials, at the fides of which channels fhould be dug eighteen or twenty inches in depth, and about the fame width; thefe muft be filled and firmly built up with ftrong turf or clay, or any other folid fubftance that will prevent the materials to be laid on the road from fpreading to either fide, openings being left at every ten or fifteen yards to let the water falling on the middle part of the road pafs through more readily But where the nature of the ground is fuch as to require to be made up, a fmall wall of the fame materials muft be built on each fide, inftead of the channels, nearly of the fame height as the furface of the road is to be. By this means the hard materials which are laid on will be prevented from fpreading, which is the chief reafon of roads in fuch foils fo fuddenly giving way; and thefe materials will not be fo apt to fink down into the fand, efpecially if it have been well rolled before their application, and at times after it has been finally completed *.

If materials can be readily procured to cover the road from fide to fide, and it have a fence at each fide, the walls will not, it is remarked, be fo neceffary, as they are principally intended to keep the folid materials together, where they are not to be applied the whole breadth of the road. Should thefe fmall walls, however, be found neceffary, the fpaces at the fides, by being coated with gravel or free-ftone fand, will make good foot-paths.

In clayey foils the roads are, it is obferved, for the moft part extremely bad and difagreeable; and principally for this reafon, that proper fteps are not taken to guard againft water ftagnating on their furfaces. This may, indeed, occafionally arife from the want of materials, fuch as fand and gravel, though it is far from being commonly the cafe. It is remarked, in the valuable paper juft quoted, that "it feems hardly ever to have occurred to thofe who have had the direction of fuch roads, that *fand*, properly applied, would, in a great meafure, remedy all the defects complained of;" and there are very few diftricts of a country, it is added, in which fome fort of fand, free-ftone, rock or fandy gravel, may not be obtained, by proper exertions, though in fome fituations it may be procured with greater expence and difficulty than in others. But where no hard materials at all can be had, if the roads were formed in a fimilar way to thofe we have defcribed above, the inconveniences attending them would moft probably be readily removed. The clayey foundation fhould be pared

* See Beatfon in Communications to the Board of Agriculture, vol. I.

away in fuch a manner as to form a ridge in the middle of the bafis or bottom part; and flight openings or drains be made at every ten or fifteen yards, or at fuch places as are hollow, in order to conduct off the moifture into the principal drains. The foundation, thus prepared, being then filled up with fand, or fome other porous fubftance eafily procured, and finifhed in the way that has been already mentioned, a good road may be formed. The manner of effecting this bufinefs may probably, however, be better underftood by confulting the plate.

In making roads through bogs or moraffes, the firft thing to be done is to drain or draw off as much of the ftagnant water as poffible, which may often be beft accomplifhed by cutting ditches or drains of fufficient depth on the infide of the fences, where they are inclofed, or defigned to be inclofed, on the fides. For this purpofe, fuch drains fhould, however, be formed a confiderable time before any thing further is attempted. Twelve or fixteen months, according to the ftate and circumftances of the cafes, are probably little enough, as the ground, if very boggy, will fettle very much after the water is taken off, and in fome parts probably more than others, as the foil is more or lefs moffy or retentive of water. Thefe will, therefore, be better difcovered by fuch a delay, in order to their being filled up and levelled, which is readieft done by the materials cut from off the elevations, or fuch other fubftances as are near at hand. But in whatever way this is done, the furface fods fhould be carefully pared off, both from the elevations and hollows, by a fuitable inftrument, fuch as a paring fpade, and laid afide until the hollows and depreffions are filled up and quite levelled; they fhould then be laid on again, by which means the whole furface will be rendered not only level, but of an equal degree of toughnefs, which is a point of confiderable importance.

After thefe preparatory fteps have been taken, the breadth of the part defigned for the reception of the hard materials is to be marked out, and covered with fand, or fuch other porous fubftances as have been mentioned, to the thicknefs of ten or twelve inches at leaft. This fhould then be well rolled, and finifhed in the way that has been already defcribed. If this plan be ftrictly adhered to, there can be little doubt of making good roads, even on moffy or boggy foils *.

Other methods of making roads through thefe foils are, however, fometimes practifed, as by laying a foundation of broom, furze, heath, willow, or other materials of the fame kind, and then placing the hard materials upon them; but fand or fome other porous hard material is always to be preferred, where it can be readily obtained, and where the line of the road is rendered properly dry before the materials are laid on; as woody fubftances foon begin to decay, and confe-

* See Beatfon in Communications to the Board of Agriculture, vol. I.

quently let down such mate.ials as are placed upon them, and thus quickly render the whole of the business to be performed over again.

In constructing roads in all kinds of soil, the same rules and directions that have been given above must be attended to, only varying them according to the nature of the materials that are to be employed, and such local circumstances as may have any influence.

When roads are to be cut or formed on the declivities of hills, there are a few circumstances to be attended to, in addition to those which have been spoken of, in constructing roads where the ground is nearly on a plain or level from side to side. It not unfrequently happens in these cases, that the part to be hollowed out and removed affords a sufficient body of materials for making the road, and the parts from whence they are removed seldom require any covering to be placed upon them. This, however, must be regulated by the nature of the soil, and solidity of the bottom which is thus left. Where the whole breadth of the road is made from the solid, and that has a sufficient degree of hardness, no extraneous materials whatever will be requisite, but in cases where the soil is a compound of clay and gravel, or where it is of a very soft earthy nature, an application of the principles and directions which have been already advanced will be necessary in forming it.

Where the lower part of the road is to be made up from that which is to be removed from the upper, it should be constructed considerably higher at first than the proper level, or bottom of that part from which the materials are taken, in order to allow for the settling, which may be much hastened by rolling; but the hard materials should on no account be laid on before this has been well accomplished.

Where the eminence is of much height above the road, the fall of water is sometimes considerable. In general, it is the best method, in these cases, to stop the water at a short distance from the road side, and thereby prevent it from running down the face of the bank; for if it be permitted to trickle down in this manner, it will quickly, by means of frosts and other causes, destroy the bank, and choak up the drains, whether they be open or covered ones; if covered, the earth, which is constantly mouldering down from such causes, will soon become so close and compact, that the water cannot pass through it to the drain, before it runs off upon the road; and if open, they are kept clear with great trouble and difficulty. But by stopping the water about five or six feet from the bank, and drawing it away to a proper outlet, the road may be kept dry with greater certainty and ease. Should the face of the bank have any irregularities, the water, in such cases, may be taken away, by having the drain to recede from

the bank in ſuch places, and keeping the courſe conſtantly on a due level; or the ſame purpoſe might be obtained by letting it be taken off in the hollows, by means of ſmall receſſes faced up with ſtone, or by ſpouts made of wood and ſet upright in the bank at theſe hollow places, and communicating with covered croſs drains under the road *.

In laying out and conſtructing theſe, as well as all other kinds of roads, it is likewiſe obſerved, that care ſhould conſtantly be taken that no water runs upon them, except what falls in rain. But in caſes where this cannot be eaſily prevented, and where a ſtream of water muſt of neceſſity run on the ſide of a road, the drains or ditches, which as has already been obſerved are the beſt on the inſide of the fences, muſt be made of ſuch dimenſions as are ſufficient to take the water that may come into them at different ſeaſons. Thoſe ſmall drains, filled with ſand or gravel, which have been ſpoken of above, are only ſuitable for ſuch roads as cannot have any ſuperabundant quantity of water at any time coming upon them.

That roads may be conſtructed in the ridge or ſloping form that has been deſcribed above with much propriety and ſucceſs, in various ſituations, there cannot be much doubt; though experience, which is probably the beſt guide, would ſeem to ſhew, that the ſlightly convex ſhape is not only more generally applicable, but that which admits of the materials being laid in the moſt advantageous manner, in reſpect to the preſſure and wear of heavy carriages, as well as other points of importance. But whichever form may be adopted, the road ſhould never have much elevation in the middle, or be greatly rounded, only ſo much that the water may be well and eaſily taken off †; as where either the one or the other is the caſe, there muſt be great inequality produced in the preſſure of carriages, by the weight being ſo much thrown on the lower wheel, and an increaſe of friction, from the inſide of that part of the wheel through which the axle-tree paſſes bearing too hard againſt the ſoulder, and the outſide too much on the pin which confines it in its ſituation; by which the difficulty of the draught is greatly augmented and rendered more inconvenient for the animal. And further, accidents are more liable to take place in conveying top loads, or ſuch ſubſtances as are of a liquid nature ‡.

There is another method of conſtructing roads, which may be applicable in certain circumſtances, and particular ſituations. This is that of forming them of rails of wood or iron, of different ſizes, according to the ſituation and weights

* See Beatſon in Communications to the Board of Agriculture, vol. I.

† Donaldſon's Modern Agriculture, vol. IV. p. 78.

‡ Holt's Hints in Communications to the Board of Agriculture, vol. I.

that are to be carried, with grooves in them for the wheels to run in*. Theſe are laid on a perfect level, and *inclined planes* formed where neceſſary, the ground being firſt formed true, and rendered dry by drains. By which, and the uſe of proper machinery, heavy carriages may be forced up or let down as the nature of the caſe may require. As roads of this kind are very liable to wear out where wood is employed, it is probably the moſt adviſable, in moſt caſes, to have them made of caſt-iron ; and they ſhould always be double, one being placed at a ſmall diſtance from the other, having communications, at ſuch diſtances as may be convenient for the purpoſe of paſſing in either direction: where iron is uſed, it is by much the beſt way to have the rails ſecured in ſtone-work, as when prepared in this way, it would be very little liable to be out of order. The carriages, of whatever kind, which are to travel on ſuch roads, muſt be adapted to the purpoſe ; the beſt general mode of conſtructing which, where heavy loads are to be carried, would probably be that of their having low iron wheels. The principal advantages of roads of this nature are, that great weights may be conveyed on them at little expence of team, while they do not coſt much more in forming than well-made turnpike roads. Extenſive roads on this plan are met with in different places, as near Colnbrook-dale in Shropſhire, and at Orrel near Wigan, Lancaſhire, for the purpoſe of conveying coals, &c. It is probably in ſituations and for uſes of this kind that ſuch roads can be had recourſe to with the moſt advantage, as by means of them the cutting up and deſtruction of other roads may be much leſſened or wholly prevented.

Repairing Roads.—However common the practice may be for the ſurveyors, or overlookers of roads, to permit them to be much cut and broken up before any effectual means are employed in repairing them, it is certainly extremely injudicious and expenſive ; as experience has fully ſhewn, that it is much the moſt economical plan to never allow them to get out of repair to any conſiderable degree. Where circumſtances will admit of it, the beſt, and probably the moſt ſaving, method of proceeding is, that of having ſuitable experienced perſons appointed in every townſhip or diſtrict, or for a certain extent of road, for the expreſs purpoſe of ſeeing what parts are in a bad condition, where water ſtagnates, or deep and improper ruts are formed, and to repair and remove them as expeditiouſly as poſſible.

In filling up and repairing the hollow parts, as well as the tracks which are formed by carriages, care ſhould conſtantly be taken that all the water be previ-

* When made of iron, from 20 to 40 lb. per yard is the uſual weight: 33lb. is ſufficient for carrying two tons. A bar of bet-iron, one inch and half in breadth and ⅛ of an inch in thickneſs, is ſometimes fixed on wooden ſleepers for the ſame purpoſe.

ously well drained off, and the loose mud or earth effectually removed. In some cases, however, wheel-tracks may be restored to a proper state, merely by the removal of their sides, without any filling up; but the substance thus removed is highly improper for being deposited in the ruts again, being of too soft and earthy a nature for such repairs. Indeed, the common practice of throwing down the sides of wheel-ruts in order to render them level, is but a very transitory and ineffectual repair. Suitable hard materials should always be had recourse to in such cases.

In constructing and repairing roads, it is also a circumstance of more importance than is generally supposed, that the quality of the hard materials should be as nearly equal as possible, and that where stones are employed, that they be broken down as much as can be to an equality of size; for it is well known that where the size of the stones made use of is various and unequal, the road will wear in holes and uneven. This is sufficiently shewn by what happens in a road when stones lie at or near the surface which are larger and of harder qualities than those of which the rest of the road is composed, as hollows or depressions are constantly produced by the opposite wheel to that which passes over such stones. This also affords a reason for removing every thing out of roads that has any tendency to throw carriages of any kind too much on one side, and for immediately filling up and repairing the parts of wheel-ruts which are more cut down on one side than the other.

Where gravel or ballast is employed, it should, likewise, be as equal as possible, and well freed from clay, and all sorts of earthy materials that it may contain. This separation might probably, in some cases, be greatly promoted by having the gravel dug in the autumn, and letting it be once or twice turned over during the winter, after having been thoroughly moistened, in order that it may be exposed to the action of the frosts, in a state the most suitable for being broken down and separated. In regard to the size of the ballast that is made use of in repairing roads, though it is common to require it large, such as is of a middling equal size is, in general, to be preferred, as binding better and sooner on old roads.

In the winter season nothing should be done to roads in the way of repairs, except in cases of necessity, such as the restoring of places that may have suddenly given way, or been much cut up. The mud and stagnant water on the surface must, however, be constantly attended to and removed; and proper materials may, during this season, and especially when there is a hard frost, be collected and carted to such situations as may require them when the summer advances, which is the proper time for making and repairing roads. But in

doing this, unleſs the repairs are to be immediately performed, ſuitable places ſhould be provided for them, inſtead, as is the common practice, of depoſiting them in heaps on the ſides of the roads.

About the latter end of March, or beginning of September, when ſuch periods are ſufficiently dry for the buſineſs, is by much the moſt proper for putting freſh materials upon roads, as they are then not prevented from binding or becoming firm, either by too great drought, or too much wetneſs. In the firſt a moderate coat, where it is wanted, ſhould be laid on, and in the latter a more full and complete one. But before any ſort of material is applied, the road muſt be well ſcraped and cleaned, and the hollows and ſoft places, after being ſcooped out, and the bottoms well looſened, filled up level with good hard materials, rammed in by means of a heavy rammer. In this way ſuch places are rendered as hard and firm as any other part of the road. In the application of the ſurface materials afterwards, great care ſhould be taken that they be ſpread out as equally as poſſible over the whole.

By rolling with a heavy roller, as has been already noticed, much advantage may be derived in the reparation of roads, eſpecially if the hard part of the materials thrown out by the preſſure of wheel-carriages, be reſtored previouſly to the operation of ſuch a roller; as it can hardly be ſuppoſed that materials, however good, when put on in a looſe manner, can remain in their ſituation, or be durable, though it is a practice too commonly followed by the overlookers of roads, who but ſeldom employ any kind of inſtrument for the purpoſe of conſolidating the materials they apply in making repairs. If this mode was made uſe of at an early period, before any very large portion of the gravel or other matter was removed, in many caſes no other means whatever would be neceſſary.

With a view to reſtore the ſtones, gravel, and other materials, which may have been thrown up or diſplaced by the action of different kinds of wheel-carriages, implements of various ſorts have been propoſed; but the common rake and ſpade, in the hands of an expert labourer, are probably the beſt. The *road-harrow*, invented by Mr. Harriott, ſeems to anſwer pretty well where roads are repaired with ſmall ſtones or gravel. The inventor aſſerts, that "a man, a boy, and two horſes, will do three miles in length in one day, completely harrowing down the quarters, and drawing the ſtones together, which, by means of the mould-boards, are," he thinks, "dropped into the ruts, far better than a man can ſtub them in."

Where ſuch a machine can be uſed, the ſaving of expence may, of courſe, be very conſiderable; a repreſentation of it may be ſeen by conſulting the annexed plate. Rolling in the manner that has been already deſcribed ſhould, however,

conſtantly be had recourſe to after the uſe of this harrow, in order to make good work, or render the road ſufficiently firm and ſolid.

In making the repairs of roads, the choice of materials muſt chiefly depend on the facility of their being found, and the convenience of conveying them. On the principles which have been laid down, it muſt be evident, that a good foundation for a road is a *ſtratum* of any porous ſubſtance, ſuch as ſand, or ſandy gravel, or even the refuſe of free-ſtone quarries. The harder materials being then applied, the beſt of which are ſtones broken very ſmall and evenly, or gravel, and the more hard and brittle the ſtones are the better. One load of ſtones prepared in this way is ſaid to be more valuable in repairing roads, than three loads of ſuch gravel as is taken from the beds of rivers, or from commons, as it furniſhes a firmer bottom, at the ſame time that the ſurface is more equal, uniform, and durable. Where other ſtones can be procured, thoſe of a calcareous nature ſhould, however, never be employed, as they ſoon moulder down, and undergo a ſort of decompoſition, by which a kind of clay is produced, that in wet ſeaſons renders the roads extremely dirty, and cauſes them to retain water on their ſurfaces, which is prejudicial in a very high degree. Where ſmall ſtones are made uſe of as the finiſhing coat, they ought always to be thinly ſpread over with fine gravel or free-ſtone ſand, in order that the crevices may be well filled up, and the road be thereby rendered more durable.

Where roads are repaired with ballaſt, after the holes, tracks, and hollow places, have been properly filled up, and the water well drained off, as already noticed, a ſlight covering, in places where it is wanted, after the foundation or ground has been well looſened at the bottom, ſhould be applied at the times, and in the manner ſtated above. If roads repaired by this ſubſtance be covered too ſoon in the year, it is, however, apt to be too much reduced before the winter ſets in, which is the time they ought to be in a good and firm ſtate.

In the forming and repairing of communication parochial or private roads, attention ſhould conſtantly be had to the different principles and circumſtances which have been detailed in conſtructing thoſe of a public nature. Under the preſent ſyſtem of management, in theſe caſes little improvement is, however, to be expected, as the means are far from being ſufficient for the purpoſe, and thoſe who have the temporary direction of them, are ſeldom ſufficiently well informed in reſpect to the nature and principles of conſtructing or repairing ſuch roads, to perform the buſineſs to the greateſt advantage. Indeed, until the veryinadequate and inefficient plan of ſtatute labour be completely done away, and a ſuitable equivalent in money raiſed, and at the ſame time perſons of knowledge, experience, and information, with proper ſalaries, be appointed for manag-

ing the expenditure and application in each diſtrict, under the control of the acting magiſtrates for the time, or ſome ſuch power, it is almoſt utterly impoſſible that ſuch roads can be either made or kept in a good ſtate of repair. Mr. Donaldſon, in his " Modern Agriculture," has thrown out ſome hints on this ſubject, which are not, perhaps, unworthy of attention. After recommending the abolition of thoſe ancient ſtatutes that regulate the performance of ſtatute labour, he adviſes that in every county the juſtices of peace be inveſted with power to aſſeſs the inhabitants of the diſtrict by ſome equitable ratio, whereby they may pay only in proportion to the benefit they receive. " Were this generally done," ſays he, " as is the caſe in ſeveral parts of Scotland; the counties divided into diſtricts of ſuch ſize, that the proprietors could conveniently meet as occaſion required; the money ariſing from the commutation act collected by one perſon, who ſhould be allowed a certain *per centage* on the ſum collected, be continued during good behaviour, and be reſponſible for his conduct to the gentlemen of the diſtrict; the money ſo collected be afterwards expended under the direction of theſe gentlemen, and the whole be ſubject to the review of the quarter-ſeſſions;—the pariſh roads in theſe kingdoms would," he thinks, " ſoon be materially improved. If to theſe regulations a power were added to mortgage the ſum ariſing from the commutation of the ſtatute labour for ſuch a number of years, and to ſuch an extent as was found neceſſary to put the uſeful private roads in a complete ſtate of repair, they might, in a few years, be made the reverſe of what they are at preſent. This laſt meaſure would," he conceives, " be found the moſt effectual that could poſſibly be adopted, and is, probably, the only one that can be reſorted to for the purpoſe of effecting an immediate and general improvement."

But, whatever methods or plans may be thought the moſt advantageous and effectual, in removing the inconveniences which have ſo long been complained of, in the badneſs of parochial roads, it is obvious that, in addition to this, they muſt have conſiderable effect in improving the ſtate of agriculture, by leſſening the quantity and expence of labour, as well as by facilitating the means of conveying certain kinds of materials, without which the attempts of the farmer in carrying on improvements, muſt often be very circumſcribed and ineffectual.

In general, private or parochial roads are made ſo narrow as to admit of carriages paſſing one another with difficulty, except in particular places. They are alſo, in many inſtances, extremely circuitous and winding, by which much time is loſt in the carting of materials. The ſide drains are ſeldom ſuffici-

ciently opened and kept clear, on which accounts the roads suffer considerably, as from large quantities of water stagnating upon them, deep sloughs and ruts are readily formed.

Roads have been supposed to be subject to much injury and destruction from some particular forms of wheels; thus broad ones, though conveying immense weights, have been recommended and encouraged, in preference to those of the narrow kind, which carry comparatively but a very light load. But it is not the breadth of the wheels which ought exclusively to be considered, but the form or construction of them, and the weight of load that is placed upon and carried by them; as it is clear from the effects which are produced, that the materials of roads cannot be rolled down flat, or left in a perfectly solid state, by wheels proceeding in straight directions, except where they have a cylindrical form of rim, and do not convey very weighty loads. The wheels of waggons, and other heavy carriages, though they have been required to have a certain breadth of rim, and a flat bearing on the road, have not been constructed in such a form as is best suited to consolidate, roll down, and keep the surface of roads in repair. The soles or rims of them, instead of being cylindrical, have mostly been the portion of a cone, the properties of which have lately, by various experiments, been shewn to be those:—of their having a natural tendency, in rolling, to revolve in a circular direction round their conical centres; of their requiring a constant power or force to keep them to a straight line or course; in their being confined or compelled to move in such straight direction, a rubbing and friction occurring at the rim; their augmenting friction on the axis; their causing a rubbing against the sides of deep ruts or tracks; their throwing up dirt from the hind part of the wheel; their pulverizing and greatly reducing the best sorts of materials in dry seasons, thereby causing much sludge in wet, and much dust in dry weather; their deranging and breaking the texture of the surface of the roads when in a soft or compressible state, and leaving them in a broken condition, ready to imbibe moisture, which causes all the bad effects of wet seasons and intense frosts; their promoting the destruction of paved roads, by forcing open the joints and letting in the water under the stones, which by ultimately floating and discharging the gravel, renders the stones loose and permits the pavement to sink into holes; their augmenting the labour of the cattle or team, and accelerating the wear of the tyres of the wheels by their constant tendency to drag and grind on the roads *.

The cylindrical form of rims is shewn to be free from these inconveniences, having a constant tendency to proceed in a straight direction, without friction

* Cumming in Communications to the Board of Agriculture, vol. II.

or rubbing at the circumference, or againſt the ſides of deep ruts; not throwing up dirt by the hind part of the wheel; not increaſing friction on the axis; not having preſſure againſt the lynch-pin; the ſole obſtacle to their proceeding in a ſtraight line, ariſing from the compreſſing and levelling the materials over which they paſs; have no diſpoſition to diſplace or break up the texture, or prevent the conſolidation of the parts of the roads on which they run; their frequent rolling on compreſſible ſubſtances rendering them more level, compact, and impenetrable to water, leaving them in a condition more favourable for conſolidation, and by contributing to keep the *interior* and ſofter parts of the roads dry, they are more enabled to reſiſt injury, and ſupport the cruſt that is the protection of them; have not the effect of opening the joints in paved roads, but, on the contrary, to improve them by operating as a rammer on the ſtones over which they paſs, from the *dead preſſure* ariſing from the equal velocity of all the parts; and advancing in a *ſtraight courſe* with the leaſt poſſible reſiſtance, and with greater advantages than any other ſhape, ſerve equally to improve roads, relieve cattle, and preſerve the tires of wheels* †.

* Theſe being the different effects of the conical and cylindrical form of the rims of wheels on roads, it is obvious that the latter muſt be much more beneficial in preſerving them than the former, and that the advantage gained by the uſe of them, will be proportioned to the extent of the ſurface over which they roll. Taking the difference in the effects between the conical and cylindrical form of the rims of wheels, at the rate of only one ſhilling for every acre of road rolled with the latter inſtead of the former; it is ſuppoſed by Mr. Cumming, that the probable amount of the advantage that may be thus obtained to the nation annually, by the wheels of "ſuch waggons only as travel the turnpike roads," would be as follows:

"The number of waggons in England is," he ſtates, "upwards of 96,600: and ſuppoſing that a tenth only of that number be employed on the turnpike roads, and a fourth of that tenth, or a fortieth of the whole, have wheels twelve inches broad; and of the remaining three-fourths, that one half have wheels ſix inches broad, and the other half, wheels only four inches; the ſtatement of the whole will be this:

Number of waggons employed on the roads - - -		9,660
Waggons with 12-inch wheels - - -	2415	
Ditto with 6-inch wheels - - - -	$3622\frac{1}{2}$	
Ditto with 4-inch wheels - - - -	$3622\frac{1}{2}$	
	———	9,660

"A wheel

† Cumming in Communications to the Board of Agriculture, vol. II.

The various facts, obſervations, and experiments, on which theſe very uſeful and intereſting concluſions are founded, can only be well underſtood by conſulting the valuable paper alluded to above; but the reſults of the different experiments are ſhewn in one point of view, and ſo arranged in the following table, that thoſe made under a ſimiliarity of circumſtances, both with the conical and cylindrical wheels, may be eaſily brought into a ſtate of compariſon. Thus the firſt column, A, furniſhes the number of each experiment, in the order in which they were made, for the purpoſe of referring to them when neceſſary. A deſcription of the particular circumſtance under which each experiment was attempted follows. The column B explains the number of weights which were required to draw the carriage under ſuch a combination of circumſtances, in ſuch a manner as juſt to *begin its motion* without being aſſiſted. And the laſt column, C, exhibits, on the ſcale of acceleration, the number of ſpaces that the carriage advances after the weights have ceaſed to act upon it;—which it is obſerved, "by eſtimating each diviſion on the ſcale as equal in value to *one-tenth of the weights that draw the carriage,* we aſcertain how much the reſiſtance to the

" A wheel twelve inches broad, will, in rolling thirty miles, cover a ſpace of 158,400 feet; and the four wheels of a waggon rolling a double ſurface will, at the ſame rate, in a day's journey, roll a ſurface of 633,600 feet, which is equal to the whole ſurface of four miles of a road thirty feet wide, and ſomething more than fourteen and a half acres; but rejecting fractions, and taking fourteen and a half acres as the quantity, the reſult in acres will be as follows:

2415	waggons, with 12-inch wheels, will, in a day's journey of thirty miles, roll - - - - - - -	35,012
3622	waggons, with 6-inch wheels, will roll - - -	26,259
3622	waggons, with 4-inch wheels - - - -	17,506
	The number of acres rolled in a day by all the waggons -	78,777

" And ſuppoſing all the waggons, at an average, to travel only ninety days in the year, they will roll a ſurface equal to 7,089,930 acres; which, at one ſhilling per acre, will exceed *three hundred and fifty thouſand pounds* per annum.

" But, waving pecuniary eſtimates, let it," ſays he, " be remembered, that the quantity of ſurface that is rolled once yearly by the waggons that travel the roads of England, is equal to the *entire ſurface* of 1,948,880 miles of road thirty feet wide. It is ſurely then," he thinks, " of importance to enquire, whether the wheels that roll this very extenſive ſurface, tend to improve or impair it? It is to be obſerved, that no notice is here taken of the waggons that are ſuppoſed to be employed for the purpoſes of agriculture, &c. nor of the immenſe number of carts, coaches, &c. that travel the public roads."

progress of the carriage is less than the power by which it is drawn *in decimals of that power.*

TABLE OF EXPERIMENTS.

A.		B.	C.
Number of the experiments according to the order in which they were made.	The circumstances under which the experiments were made, with the different sets of wheels.	Number of weights required to make the carriage begin its motion.	Number of spaces which the carriage advances after the weights have ceased acting.
1st.	The Conical Wheels bearing on their whole breadth, were drawn by -	9	$0\frac{1}{2}$
4th.	The Cylindrical Wheels, do. do. - - - - -	6	$3\frac{1}{2}$
2d.	The Conical Wheels bearing on a fourth of their breadth on the middle tire	6	1
5th.	The Cylindrical Wheels under the same circumstance - -	6	2
3d.	The Conical Wheels bearing on two slips on the extremities of their rims	11	0
6th.	The Cylindrical Wheels under the same circumstances - -	6	$2\frac{1}{2}$
7th.	The Conical Wheels drawn on friction bars, that remove the friction at the rim	6	$0\frac{1}{4}$
8th.	The Cylindrical Wheels on do. at liberty, but the friction bars do not move	6	1
9th.	The Conical Wheels on the friction bars (fixed) bearing on their whole breadth	9	$0\frac{1}{3}$
10th.	The Cylindrical Wheels, do. do. - - - - -	6	$0\frac{2}{3}$

The following important deductions are drawn from a comparison of the effects of each class of wheels under similar experiments, as shewn in the table, namely, that from " the *first* and *fourth* experiment," it seems evident, that the same load that is drawn on *conical wheels* by a power of nine, is drawn on *cylindrical ones* by a power of six; and that after the power has done acting, the carriage with the former kind of wheels proceeds only one *half a space* on the scale of acceleration; while that with the latter sort, though drawn by a third less power, has sufficient *motion* left to advance it forward *three spaces and a half.*

That by the *second* and *fifth*, it is clear that when the conical wheel is made to bear on a fourth part only of its breadth at the middle of the rim, it is drawn by a power of six, and proceeds *one space*, after the acting power ceases; but that cylindrical wheels bearing on the same breadth, and drawn by the *same power*, advance on the scale *two and a half divisions*; which shews that even the *narrow cylindrical* is drawn with more ease than the narrow conical wheel, and that the difference in favour of the former is, in this instance, equal to $\frac{3}{20}$ of the power by which the carriage is drawn. That the third experiment proves, that when the conical wheel bears equally on the opposite extremities of the rim, *eleven weights* are requisite to draw it; that with this increased power, it stops the moment the action of the impelling weight ceases: the uniform resistance to

its progreſs being equal to the uniform action of the power, no reſidue of motion is left to force it forward. That the *ſixth* evinces, that with the cylindrical wheels, bearing in a ſimilar manner on the extremities of their rims, *the ſame load* is drawn by *ſix* weights only; and the motion ſo accelerated as to carry the carriage two and a half ſpaces forward, after the weights have ceaſed to act upon it.

That the reſult of all theſe experiments, on the whole, ſhew that the greater reſiſtance which takes place with the broader conical wheels, does not depend on the breadth of the rim alone, but upon the breadth and the conical ſhape conjointly. That, in conical wheels, the *increaſe of reſiſtance* depends upon the difference of the velocity of the greateſt and of the ſmalleſt parts of their circumference, and that the exertion of the cattle muſt neceſſarily increaſe in the ſame proportion. That, the reſiſtance is increaſed on the ſame conical wheel, when the preſſure of the load is confined to thoſe parts of the rims that have the greateſt difference of velocity. That, on the ſame principle, the reſiſtance with the conical wheel *on a hard bottom*, is diminiſhed by narrowing its bearing; but that on yielding ſubſtances, the effect is directly the contrary. That, ſince this friction and dragging of the conical rim is owing to the different velocities of the ſeveral parts of the circumference, it follows, that every wheel which has not an equal velocity in every part of its circumference, muſt have a dragging and unneceſſary reſiſtance, that is, a reſiſtance that may be avoided by giving to every part of the circumference, or rim, the ſame degree of velocity. That, the only means by which an equal degree of velocity can be obtained in every part of the circumference of a wheel, is, by making all the parts exactly of the ſame diameter; and every wheel that has all its parts of the ſame diameter, muſt neceſſarily be *cylindrical*. And thus, that the concluſions from the reſult of experiments, and from theory, concur in proving, that ſo far as regards the labour of cattle, or the facility of the progreſs of carriages, the cylindrical ſhape of a wheel is preferable to any other poſſible ſhape: and that this ſuperiority of the cylindrical wheel, which has hitherto been illuſtrated by conſidering only the cauſes from which the greater reſiſtance with conical broad wheels ariſes, is further proved by the experiments that have been made with the cylindrical wheels; in each of which, *the ſame number of weights* were required to make the loaded carriage begin its motion, under the ſame variety of circumſtances, which with the conical wheels occaſioned the difference ſhewn in the table, in the number of the weights required to draw the ſame load; and the number of weights that were capable of drawing the loaded carriage under each of thoſe various cir-

cumſtances on the cylindrical wheels, was only equal to the leaſt that was required with the conical; and when the conical wheels bear on the extremities of their rims, five more weights are required with them than with the cylindrical wheels. And that, although no difference appears by the number of weights required to begin the motion of the carriage with the cylindrical wheels, whether they bear on the whole breadth of the rim, on a narrow part of its middle, or on the extremities of the felloes; it ſeems clear by the ſpaces which the carriage advances, on the ſcale of acceleration, after the weights have done acting upon it, that when the cylindrical wheel bears on its whole breadth, it advanced on that ſcale $3\frac{1}{2}$ ſpaces, when bearing on one-third of its breadth only, it advanced only $2\frac{1}{2}$ ſpaces; and when bearing on a fourth of its breadth only, it advanced no more than 2 ſpaces: here then, it is obſerved, is ſeen a moſt important difference between the cylindrical and the conical wheel; namely, that *the broader the bearing of the cylindrical wheel,* the more eaſily it proceeds, and that the broader the bearing of the conical wheel, the greater is the reſiſtance to its progreſſion*.

On theſe grounds and principles it is ſuggeſted, that the uſe of low broad cylindrical wheels, with light carts, may be advantageous for many purpoſes of the farmer, ſuch as conveying manure on tillage and meadow land, in all kinds of ſeaſons.

And the ingenious writer concludes that, on the whole, cylindrical wheels muſt therefore be beneficial to the proprietors of waggons, by their leſſening the labour of the cattle on the *ſame road,* as well as keeping the roads in a more improved ſtate of repair; and to the *truſtees* of roads, by their improving them, and rendering leſs expence in repairs neceſſary, independent of the leſs injury done to the roads uſed by the farmer.

In reſpect to the form or ſhape of roads, in ſo far as the effects of wheels are concerned on them, it is evident, that as the effect of every ſhape of wheel, whether it be cylindrical, or of the conical and more rounded form of tire, muſt be that of forcing the materials of which they are compoſed *laterally*, and this in proportion to the ſupport which they have at the ſides. Roads ſhould not have too much of the convex or rounded form, having, under ſuch circumſtances, the leaſt ſupport at the ſides, to which, on that account, the materials are continually forced by the preſſure of carriages in the middle, where the great bulk of materials is uſually laid. It is in this way that convex roads ſoon become in a degree level.

* Cumming in Communications to the Board of Agriculture, vol. II. p. 408.

Wheels that have the greateſt elevation in the middle of their rims, or are the moſt rounded in their ſhapes, will have the moſt effect in this way, as well as in breaking up and deſtroying the cruſt or ſurface of roads, and of courſe muſt be the moſt prejudicial to them*.

As the goodneſs of roads, and the expences of keeping them in repair, are alſo conſiderably influenced by the nature of the fences that are made on the ſides of them, it may not be improper to take notice of a few circumſtances which reſpect them.

In caſes where the ſituation of the ground on the ſides of roads is ſuch as to allow of ſunk fences being made, they are unqueſtionably the beſt, as they contribute much to the keeping of them dry. They may be conſtructed in the manner of open ditches or drains, and of ſuitable depths, the deepeſt parts being conſtantly on the ſide of the fields. But where they lie open to the roads, this can ſeldom be done with ſafety. By having the fences and ditches formed in this manner, the foundation of roads may be more eaſily kept free from moiſture, and at the ſame time more ſpace be allowed for travelling upon, than in caſes where the ditches are conſtructed on the ſides of the roads.

Where the fences are formed of ſtone or ſod, or even of quicks, they ought not to be higher than two or three feet above the ſurface of the road; but if a pailing be made uſe of, it may with advantage be ſet higher. By keeping the fences low, the roads will be more expoſed to the action of the ſun and wind, and conſequently ſooner rendered dry, and free from the ſtagnation of moiſture. Wherever high hedges or trees grow on the ſides of roads, they keep them conſtantly wet and dirty; the former ſhould, therefore, be cut to the height of five or ſix feet, and the latter be either pruned cloſe to near the tops, or totally removed. Neither trees nor plantations of any ſort ſhould be planted ſo near the ſides of roads, as to prevent evaporation from rendering them quickly dry. Where trees are, however, to be planted in the neighbourhood of roads, the diſtance ſhould ſeldom be leſs than ten or fifteen feet from the fence, and forty or more from each other; in which caſes they muſt be protected while young from cattle by hurdles, or a pailing of ſome other kind.

* Cumming in Communications to the Board of Agriculture, vol. II.

CONSTRUCTION of ROADS.

Fig. 1.

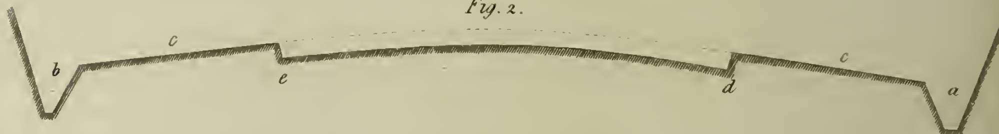


Fig. 2.

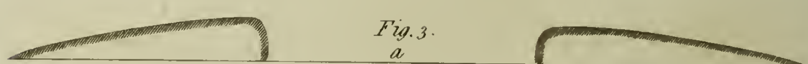


Fig. 3.

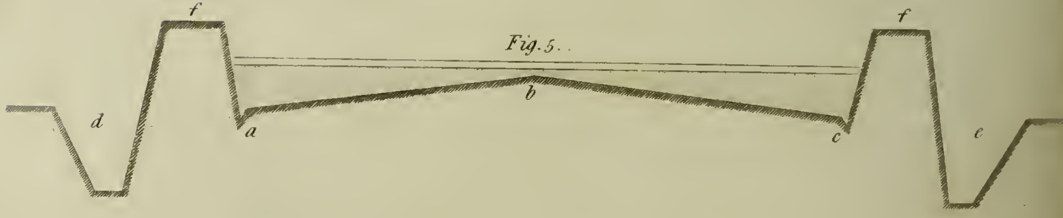


Fig. 5.

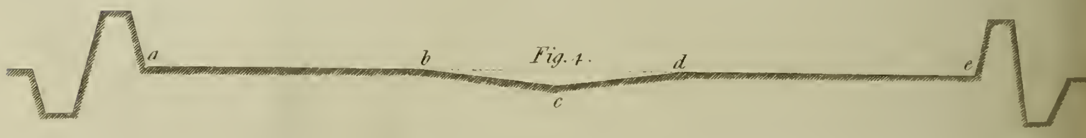


Fig. 4.

PLATE XXXV.

Conſtruction of Roads.

[*To face Page* 174.]

Fig. 1. Represents the ſtratified nature of the earth in the ſection of a hill or elevated ground, as 1, 2, 3, 4, &c. 1. The upper porous *ſtratum*. 2. The retentive ſtratum below, which confines the water until diſcharged at *b*: if the *ſtratum* 2 be hollow at *a*, and proceeds towards *f*, it then lodges in that hollow, forming ſoft ground there; but if at this hollow a communication is formed with the *ſtratum* 3, which is porous at *a*, no water will ſtand there, but penetrate through it to the impervious *ſtratum* 4, on which it glides till it finds vent on the ſide or bottom of the hill. It is evident in the figure, that if the upper *ſtratum* 1 be retentive, water falling on it will not only lodge in the large hollow *a*, but alſo in the ſmall ones, *c d e*, &c.

Fig. 2. Shows the manner of forming a convex road, in which *a* and *b* exhibit the ditches or drains on the ſides; *c c* foot-ways, or horſe-roads when ſufficiently wide; *d e* a convex line, ten or twelve inches lower at *d* and *e* than the foot-way. The ſpace ſhown by the dotted line is to be filled up with hard materials.

Fig. 3. Exhibits another plan of forming convex roads, in which *a* is the hollow in which the hard materials are depoſited, the bottom of which is flat inſtead of being convex as in the former, and of greater depth, conſequently requiring a larger proportion of materials.

Fig. 4. Repreſents an improved mode of forming roads, in which the lines *a b* and *b c*, inſtead of being convex, are quite ſtraight, meeting in an angle or ridge at *b*, ſloping to each ſide regularly about an inch in a foot: *a* and *c*, ſmall drains for conveying off the water collected at theſe places.

Fig. 5. Exhibits a croſs ſection of a concave road, in which the whole breadth *a e* of it is divided into three equal portions, as *a b*, *b d*, and *d e*, the ſides *a b* and *d e* being formed quite flat; but the part *b d* has a gradual ſlight deſcent each way to *c*, the middle of the road; it has alſo a ſlight deſcent in a longitudinal direction for conveying off the water at proper outlets; *b d* the place in which the hardeſt materials are laid. In this form of road there are three parts on which carriages can go, as *a b*, *d e*, and *b d*, in which the horſe-truck is at *c*.

Fig. 1.

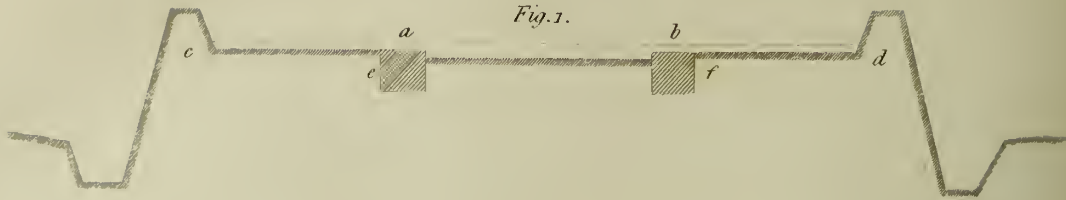


Fig. 2.

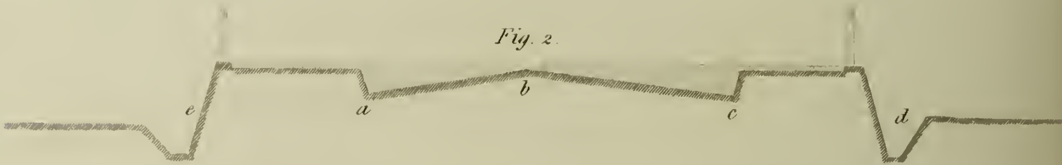


Fig. 3.

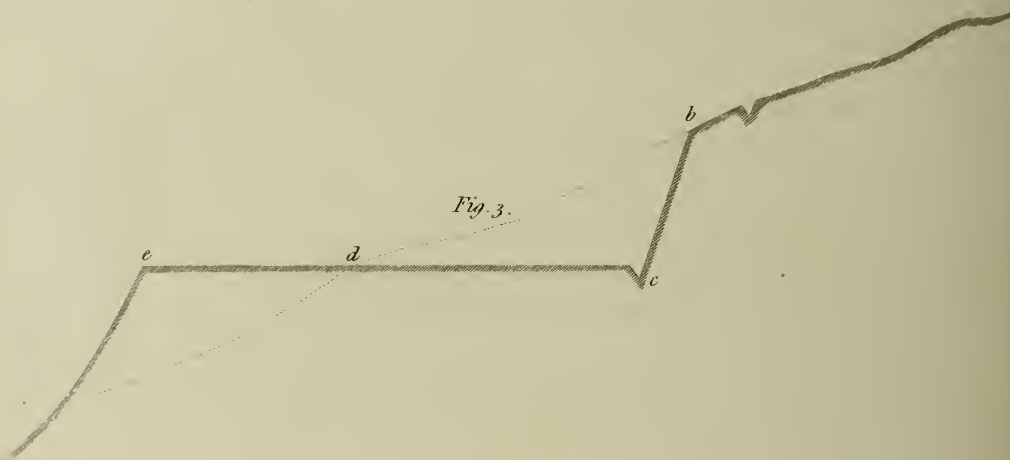


Fig. 5.

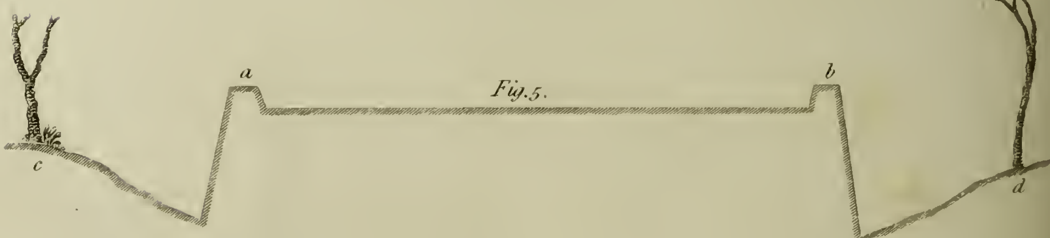


Fig. 4.

PLATE XXXVI.

Conſtruction of Roads.

[*To face Page* 174.]

Fig. 1. Is the repreſentation of the plan of a road made in a looſe ſandy ſoil. After forming it to the full width for the hard materials, dig channels, *a* and *b*, where neceſſary at each ſide, 18 inches in depth, with the ſame width, filling them up with ſolid materials, as ſhown at *e* and *f*, to prevent the others from ſpreading out laterally, which is the chief difficulty of forming roads in ſuch ſituations. It is recommended by Mr. Beatſon.

Fig. 2. Exhibits the form and method of making roads in clayey ſoils: *a b c* the clay hollowed out for the porous materials, ſo as to leave a ridge in the middle of it; the dotted lines, *e a* and *c d*, drains to conduct away the water at ſhort diſtances into the main drains *d* and *e*.

Fig. 3. Shows the form of roads made on the ſides of hills: *d c* the part cut out of the ſolid, which in moſt caſes will require no covering; *d e* the part made up, which at firſt ſhould be higher than the other; *b c* the face of the bank: the water from above ſhould be intercepted at *b* to prevent its being injured and the drain *c* being choked up. In irregular faced banks it may ſometimes be neceſſary to let off the water by wooden ſpouts ſunk upright in the banks at the hollows, as ſeen at *a b*, *fig.* 5.

Fig. 4. Explains the manner of planting trees near roads: *a b* the extent of the road; *c d* the planted trees.

4

IMPLEMENTS for repairing ROADS.

Fig. 1.

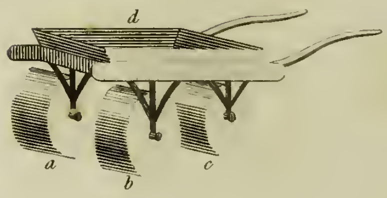


Fig. 2.

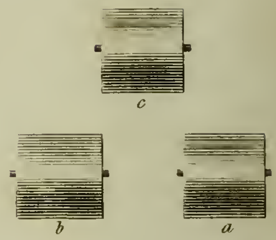


Fig. 3.

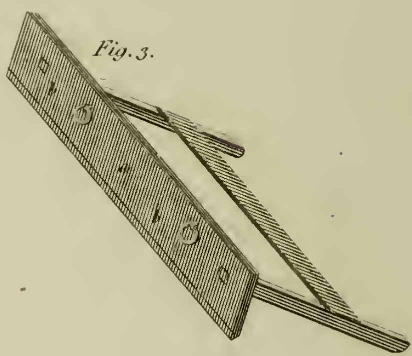


Fig. 4.

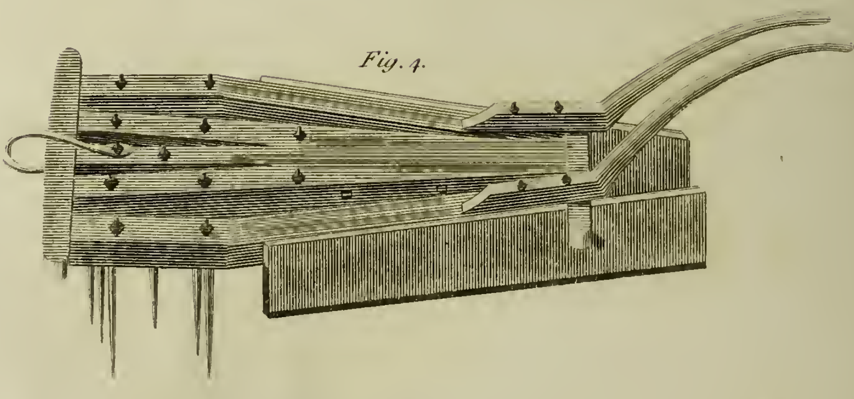


PLATE XXXVII.

Implements for repairing Roads.

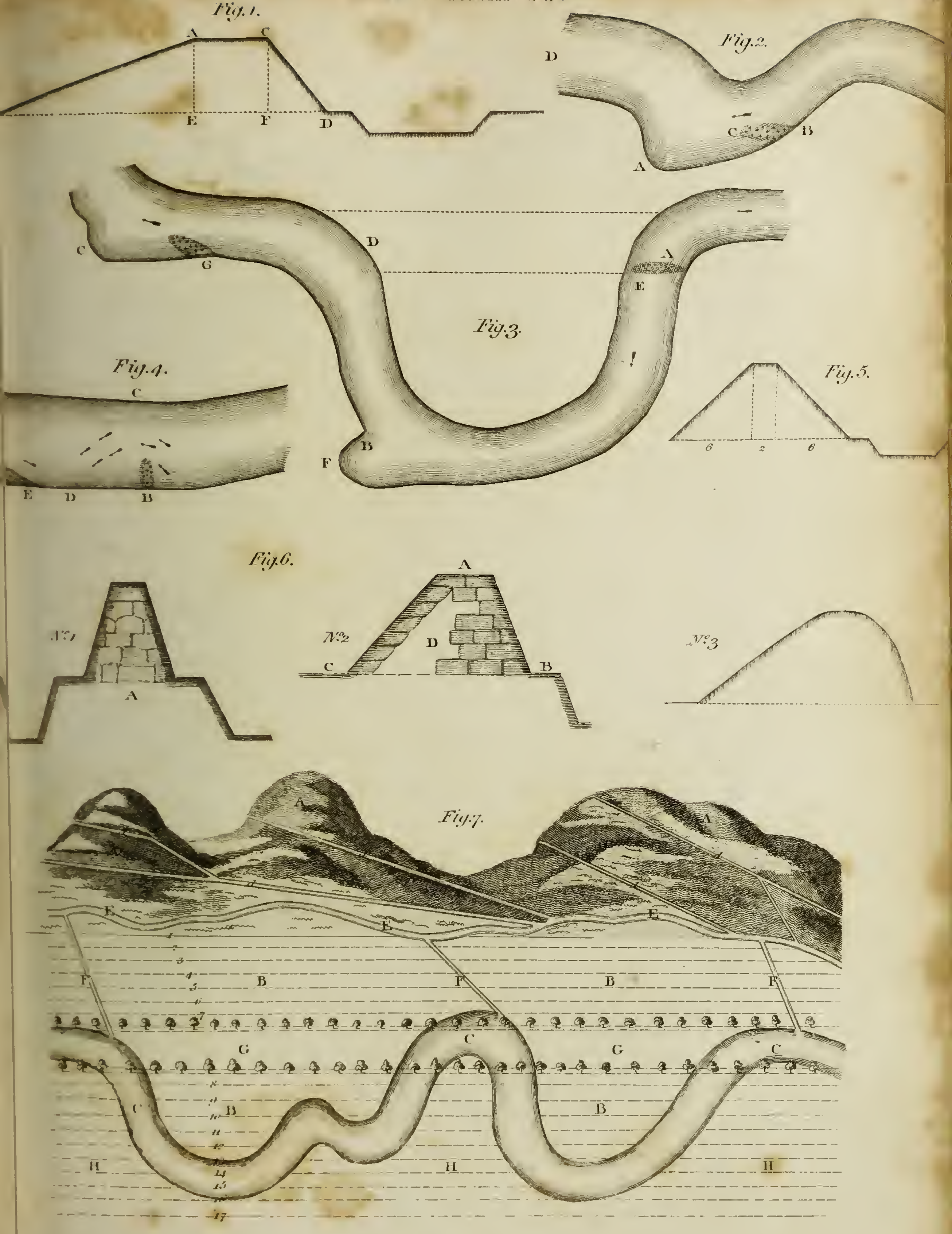
[*To face Page* 174.]

Fig. 1. Reprefents an iron roller with three divifions for the purpofe of rolling new formed roads; in which *a* and *b* fhow the two hind parts, and *c* the middle or front one to which the fhafts are attached, and which are fo conftructed as to turn in the manner of the fore wheels of a waggon. *d* a box for containing ftones to increafe the weight occafionally; two-thirds being placed over *a* and *b*, and only one-third over *c*, in order to make the preffure equal. It has been recommended by Mr. Beatfon as very ufeful.

Fig. 2. The plan of the roller as ftanding on the furface of the road, *a* and *b* the back, and *c* the fore or middle part.

Fig. 3. Is the reprefentation of an implement for the purpofe of levelling the furface of roads, and is ufed in America, according to the Bifhop of Llandaff, for levelling ground. It is conftructed of a ftrong plank, *a*, five or fix feet long, fhod with iron on the inferior part, which has a fharp edge for fcraping the road as drawn upon it. A frame is fixed at the back of the board on which the driver ftands, directing the horfe by two rings or hooks *b b*. It is recommended in this intention by Mr. Beatfon.

Fig. 4. Reprefents a harrow invented by Mr. Harriot of Great Stambridge, Effex. Its head is three feet in length from the outfides of the bars. The bars are four inches fquare and five feet in length. The mould boards extend eleven inches further to draw the ftones harrowed up nearer the middle of the road; and are four feet two inches long, ten inches depth, and two inches thick, fhod with a bar of iron, and lined fix inches with iron plate. The teeth are one foot in length from the under fide of the bars, fteeled at the point, and an inch and quarter fquare, fixed in with nuts and fcrews having collars both above and below the bars. The bars pafs in a longitudinal direction to guard againft fplitting. It is drawn by two horfes abreaft, the outfide horfe on the outer quarter, and the other in the path, a man fteadying the harrow by the handles. Thus an infide and outfide quarter are taken in going, and the others in returning. It is fuggefted as an effective implement by Mr. Beatfon.



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PRACTICAL AGRICULTURE.

PART THE SECOND.

SECTION VI.

SOILS.

SOILS.—Manner in which they are formed—Reaſon of their Variation of Quality—Cauſe of their different Degrees of Fruitfulneſs—They are injured by ſome Subſtances—Kinds which have this Effect—Reaſons why thoſe which are apparently ſimilar, turn out different on their being broken up —Cauſes of the contradictory Facts reſpecting in Agriculture—Cauſes of Soils producing one Sort of Crop in preference to another—Depth and Quality of Subſoils—The Cauſe of Differences in—Cauſes of the Difficulty of aſcertaining—Methods in which attempted—Chemical Analyſis—Natural Appearances—Nature of Plants produced by—Advantages of each—Neceſſary to have Recourſe to Experience—Have been deſcribed under a Variety of uſeleſs local Terms—May be diſtinguiſhed under a few Heads—Clayey Soils—Cauſes of the Differences of—Circumſtances to be attended to in improving them—Applications moſt uſeful for—Methods of laying them on—Advantage of proper Modes of Tillage in—Neceſſary to be kept as dry as poſſible at all Seaſons—Advantages of keeping them dry in different Caſes—Circumſtances to be attended to in their Tillage—Means of aſcertaining their Nature.—LOAMY SOILS—Admit of Variety—Subſtances of which compoſed—Manner in which they recede from Clays—Circumſtances on which their Lightneſs and Friability depend—On which their Colours depend—Admit of Improvement more readily than Clays—Applications proper in this View Reaſons for their being more eaſy of Tillage—Not ſo diſpoſed to the Production of Weeds.—CHALKY SOILS—Circumſtances which produce Differences in them—State of the calcareous Matter incorporated with them muſt be attended to—The Combination of other Subſtances with the calcareous alters its Effects—In Union with Magneſia is prejudicial to Vegetation—Cauſes which form Diſtinctions in—Applications ſuitable for improving them—Reaſons why much Strength of Draught is required in—Great Attention to the Tools employed on, always neceſſary.—SANDY SOILS —Mode of Formation of—On what the Variation of depends—Why leſs benefited than others by Heat and Moiſture—Circumſtances to be attended to in improving them—Applications proper in dif-

ferent Cafes—Reafon why different Applications are ufeful in different Diftricts—Means of fupplying them with vegetable Matter—Methods in which Manures may be applied to them—Thin Soils eafily cultivated—Caufes of the Difadvantages of.—GRAVELLY SOILS—Materials of which compofed various—Different Arrangements of in.—Why fubject to burn—Defects of, how removed—Applications proper for in different Cafes.—PEATY OR MOSSY SOILS—Met with extenfively in fome Diftricts—Caufes of the Varieties of—Stratified Order of—Caufe of great Differences in—Highly retentive of Water—Injured by its Evaporation—Means of Improvement in—Applications neceffary for.—VEGETABLE EARTH OR SOIL—Nature of, in different Cafes—Formation of, how effected—Oxygenation fuppofed to retard the Deftruction of—Means of promoting the Increafe of—Caufes which render it too light for grain Crops.

THE particles of the various folid, as well as lefs compact, bodies that are met with in nature, and which have been rubbed down and reduced by the fucceffive operations of the atmofphere, and the agency of other natural caufes, being mixed and blended together in different ways and proportions, conftitute the earthy compounds, which, from their being capable of abforbing, and in fome meafure retaining, moifture, as well as giving ftability, afford the means of fupport to various products of the vegetable kind, and form the bafes of foils in general; while the materials proceeding from the decompofition and decay of numerous organized animal and vegetable fubftances, uniting with fuch compounds, compofe the fuperficial layers of rich mould, from which plants chiefly draw or derive their nourifhment and fupport.

Soils being formed in this manner, it is evident they muft vary much, both in the qualities and proportions of the ingredients of which they are compofed. In one fituation or diftrict one fort of material is abundant, and confequently enters largely into the foil; in others it is deficient, while thofe of other kinds are plentiful, and conftitute the principal parts of the foils where they are found. Some fituations too abound much more with animal and vegetable matters than others, which produce great diverfity in regard to the foils. The harder and more firm fubftances of nature, being, on account of their ftructure, reduced more flowly, and with greater difficulty, into the ftate of earth, generally enter in much fmaller proportions into the compofition of foils, than thofe which are of a foft and pliable difpofition, and which approach nearer to the quality of earth. Thus argillaceous, loamy, and vegetable matters are found to predominate very much in foils in their primitive ftate, and, according to their particular qualities and proportions, to conftitute very material differences in their properties. Calcareous and filiceous earthy matters are diftributed over fome

diftricts in great abundance, while in others they enter into the compofition of the foils in much fmaller proportions, and thus contribute to vary their textures and qualities.

Soils likewife undergo much change and alteration from other matters of different kinds, being either naturally or artificially blended and incorporated with them, and from the proportions in which fuch mixture takes place.

There are probably few, if any, fubftances in nature, which, after they have been fufficiently acted upon, and reduced by the atmofphere and other caufes, but which are capable of affording fupport to fome fort of vegetable or other; though there is confiderable difference in this refpect among different earthy matters, fome being able to fuftain a great number of different plants in a vigorous ftate of growth, almoft immediately after they become mixed with the foil, while others require to be applied and united for a great length of time before they afford fuftenance to any kind of vegetable whatever, and even then only yield a fcanty fupply of nourifhment, and that for the fupport of a few particular forts of plants. Where the former forts of materials are abundant, the foils are generally fertile and productive; but where the latter prevail, they are moftly fterile and unfriendly to vegetation*.

Soils are affected by other caufes: befides poffeffing the proper earthy matters, they muft be embued with other principles, fuch as the aqueous and carbonaceous, and have fuch a confiftence and texture, as will properly fupport the plants, as well as fuch proportions of the feveral materials as will admit of their being retained, and applied in fuch quantities as are fuitable for the purpofes of vegetation according to the differences of climate in refpect to moifture, and the varieties of fituation in regard to the lands, in order to be rich, fruitful, and productive.

The fubftances, fo far as they are yet known, that have a tendency to leffen the fertility of foils, are the oxyds or calces of particular metals, fome coaly and pyritical matters, acids, and certain heathy vegetable fubftances. But fome of thefe fubftances, though unfriendly to the growth of vegetables when in thefe circumftances, on being blended and united with other materials that enter into the compofition of foils, operate upon them in fuch a manner as to render them more fertile than they would have been without them. Mixtures and impregnations of this nature are conftantly taking place in foils, which cannot be eafily comprehended or afcertained, but which produce great and important effects and changes in them. From this caufe, foils, which are apparently fimilar in every refpect, on being brought into

* See Anderfon's Recreations in Agriculture, &c. vol. I.

cultivation, frequently turn out to be effentially different. Hence, too, originate many of thofe facts and conclufions that appear fo oppofite and contradictory in the fcience of agriculture; it is on thefe principles, likewife, that foils are capable of producing certain kinds of plants in great abundance and perfection, while others cannot by any means be raifed upon them. It is well known to moft perfons converfant with practical agriculture, that foils in which calcareous matter is predominant, even when they are grown fo poor and exhaufted as to be almoft incapable of producing any of the other crops commonly cultivated on them, will bear large and repeated crops of one fort of vegetable, that of faintfoin; and that other foils which are capable of affording the common crops in an abundant manner, cannot be made to produce this. In the fame way, fuch calcareous foils as have been cultivated for a great length of time, and are confequently much impregnated with manure, afford plentiful crops of barley; while oat crops, if attempted to be raifed upon them in fuch a fituation, are weak, puny, and relatively extremely fmall. And, on the contrary, fome primitive foils, not originally containing any calcareous materials, and which, not having been cultivated, cannot be impregnated with manures on firft being broken up, often yield aftonifhing crops of oats, while barley can fcarcely be raifed at all upon them. There are many facts of a fimilar nature fcattered through the writings on hufbandry, but thefe are fufficient to fhew the great influence that very flight impregnations of different matters have in varying the properties of foils, and in rendering them more fuitable for the production of one fort of crop than another, while no perceptible external differences are exhibited, by which the ableft agriculturift can be led to decide with certainty refpecting their qualities.

In addition to thefe caufes of diverfity in foils, there are others that arife from their variations in refpect to depth, and the quality of the fub-foils on which they are placed. It is a fact well known by practical farmers, and which the experience of every day confirms, that even the foils that are conftituted of the moft fuitable fubftances for the purpofes of vegetation, when only a few inches in depth, and depofited upon beds of cold wet clay, rock, or chalk, are by no means fo fruitful and productive as thofe which are thicker, though of inferior quality, but refting on a bottom which is more dry and gravelly. The difference of weight and tenacity in the under ftrata of foils, likewife introduces great variety in regard to their powers and capabilities of rearing vegetable productions.

In a fubject where there is fuch great diverfity, originating from fuch

minute circumſtances, and almoſt imperceptible cauſes, as is the caſe in reſpect to the nature of ſoils, it is extremely difficult to point out any rules or marks by which they may invariably be aſcertained. Several methods have been propoſed by agricultural writers for the accompliſhment of this highly neceſſary and important point. The mode by chemical analyſis is unqueſtionably the moſt certain and exact, but it requires, for the moſt part, more knowledge and dexterity than is commonly poſſeſſed by the mere practical farmer, and in many caſes is tedious and expenſive. It can, therefore, be only well executed by thoſe who are converſant with the ſcience of chemiſtry, and to whom expence is no material object. The natural appearance of a ſoil may, in certain inſtances, afford the means of aſcertaining its quality; but as few perſons are ſufficiently acquainted with the vaſt varieties of ſoils which occur in nature, it is a method that muſt obviouſly be extremely uncertain and confined, and which on many accounts is open to great objection.

There is another means of deciding in reſpect to ſoils, which, in many caſes, when properly limited and exerciſed, by a perſon of ſound judgment and duly experienced, is certainly not a bad one, though in ſome reſpects alſo defective: it is that of determining from the nature of the plants that are produced, and the degrees of their growth and luxuriance. Thus, where plants that are only accuſtomed to grow in good or peculiar ſorts of ſoil, are met with in their natural and flouriſhing ſtates in other places, the ſoils may be concluded to be of this or that kind, according to the circumſtances in which they are found. In this way the common nettle and the ruſh may characteriſe different deſcriptions of ſoil; the former being found to grow the moſt luxuriantly on the dry loamy ſoils, while the latter delights in the wet cold clayey ones. The growth of certain ſorts of timber trees and hedges, may alſo, in various inſtances, ſerve to direct the judgment, and likewiſe the appearances or colours of the mould in particular inſtances; thus, hazel brown denotes a good ſort of loamy ſoil, and reddiſh ſandy earth, a favourable one of the lighter kind. Too few obſervations have, however, yet been recorded by practical writers, concerning the diſtinctions afforded by the growth of different plants on different ſoils, to render it a method of extenſive utility and application. Until farther attempts be made, therefore, in this or ſome other way, and a more full and ample collection of facts be brought forward, the ſafeſt and moſt advantageous plan will, probably, be to reſt upon the baſis of experience, by which, from the combination of various little circumſtances, the agricultor may, in moſt caſes, be led to a ſafe deciſion.

The ſoils of this country have been deſcribed under numerous heads, and diſtinguiſhed by an uſeleſs variety of vague local terms. They ſeem, however, to be capable of being conſidered and characteriſed, as far at leaſt as is neceſſary for practical purpoſes, under the diſtinctions of

Clayey,	*Chalky,*	*Peaty or Moſſy,* and
Loamy,	*Sandy, Gravelly,*	*Vegetable Earthy ſoils.*

Each of theſe diviſions muſt of courſe comprehend ſeveral varieties, according to the nature and preponderancy of the different ſorts of materials of which they are conſtituted or compoſed.

CLAYEY SOILS.

Soils of this kind differ very materially, according to the nature and quantity of the clay that enters into their compoſitions, and the adulteration which has been produced in it by the intermixture of different earthy matters, as well as various mineral, vegetable, and animal ſubſtances. For clays are, in general, far from being pure in the ſtates in which they are found in the earth. They are in many inſtances united with large proportions of ſiliceous or ſandy matter. On theſe accounts it is that the clayey ſoils of ſome diſtricts are ſo abundantly fruitful and productive, while thoſe of others are inſuperably ſterile and refractory. Farmers, or thoſe engaged in cultivating land, for the moſt part being only acquainted or converſant with earth or mould, as it offers itſelf to their attention in the groſs or whole, have not been led to remark the aſtoniſhing diverſity that takes place in reſpect to the properties of clays, and other bodies that are united with them, as primitive and conſtituent parts of ſoils, in their original and native ſtates; but having found that they all agreed in poſſeſſing the property of imbibing and retaining moiſture, and thereby becoming ſoft and ductile, have, probably too haſtily, concluded them to have, in ſome meaſure, a ſimilarity in their other qualities. In this way erroneous notions have frequently been engendered reſpecting ſoils in which theſe ſubſtances abound. For it is well aſcertained from the uſe of clays in ſtates of greater purity, that there are very eſſential differences in their qualities. There are ſome ſorts, as that which is denominated fullers-earth, and ſeveral of the ſofter boles, that have the coheſive property in but a very ſlight degree; while others, ſuch as thoſe which are termed *tills,* are ſo extremely tenacious and viſcid, as to be capable of being drawn out into threads. And there are ſtill others which, from their ſoftneſs and property of imbibing water readily, are capable of being cut with great facility by any ſharp inſtrument; while ſome other ſorts are ſo

firm, hard, and compaƈt, as ſcarcely to admit of being ſoftened by means of water. The clays which are employed for making the fineſt porcelain, and thoſe uſed in the compoſition of the more coarſe wares, are only to be met with in particular ſituations and diſtriƈts*.

Theſe faƈts not only ſhew that there is a prodigious variety in reſpeƈt to the qualities of theſe ſubſtances, but that they muſt afford equal variety to the ſoils into which they enter, and therefore require to be more cloſely examined and more nicely aſcertained than they appear yet to have been, before *all* the varieties of ſoil uſually claſſed under the denomination of clayey can be well aſcertained and underſtood.

But theſe ſubſtances do not differ only in their properties and qualities, but likewiſe in their colours, and the cloſeneſs with which their particles are united. They are found in their natural ſtates of various colours, ſuch as red, white, blue, and yellow, and of different degrees of denſity, ſo as, in ſome inſtances, to readily admit of being united with the different materials that are applied, in order to ameliorate their conditions; in others they can ſcarcely be made to join with them by any means in the power of the agriculturiſt. In ſoils of the firſt kind, the quantity of ſiliceous or ſandy matter, in general, bears a much larger proportion to that of the argillaceous or clayey, than in thoſe of the latter, and in many caſes too the mixture of other ſubſtances is proportionably larger. The nature of the clayey ſtratum, in reſpeƈt to its thickneſs or thinneſs, as well as its contiguity or remoteneſs from ſprings of water underneath it, is too commonly overlooked in conſidering theſe ſorts of ſoils; but all theſe circumſtances demand particular attention, and ought to have conſiderable influence in direƈting the means of cultivating and improving clayey ſoils.

It is obvious, from what has been already advanced, that, notwithſtanding the differences that take place from the accidental mixture of different materials, in different degrees and proportions, all the deſcriptions of this ſort of ſoils muſt poſſeſs more or leſs of the heavy and adheſive ſtiff qualities; and that according as theſe are more or leſs predominant, due reſpeƈt being at the ſame time had to the various other circumſtances that have been ſtated, the buſineſs of cultivation and improvement muſt be varied and applied. In general they will require greater ſtrength, and more labour and exertion, to bring them to that ſtate of pulverization and fineneſs, which is the moſt ſuitable for the various intentions of huſbandry, than may be requiſite in many other kinds of ſoils. Beſides this, as they are frequently defeƈtive in the proper ingredients for the ſup-

* See Anderſon's Recreations in Agriculture, vol. I.

port of vegetation, and faulty in their texture, as well as combined with principles which are neceſſary to be corrected; the applications of ameliorating ſubſtances ſhould conſtantly be conducted with theſe, as well as other views. Chemical analyſis has now ſhewn, in the moſt fully and ſatisfactory manner, and the fact has been confirmed by the general experience of practical farmers, that ſubſtances of the calcareous kind are the moſt advantageous in improving and bettering the condition of all clayey ſoils. Where the deficiency is in the texture, and the want of the calcareous ingredient, lime-ſtone gravel and calcareous marles are the moſt uſeful and proper. If, however, theſe ſubſtances cannot be procured, a mixture of the coarſer kinds of ſand with perfectly effete or extinguiſhed lime may be employed; and even chalk, ſand, or lime-ſtone, in the ſtate of coarſe powder. Coal aſhes, clay which has undergone the heat of the fire, and ſmall pebbly gravel, are alſo ſometimes uſeful. Lime alone may frequently be made uſe of with great and permanent benefit; though it is thought by ſome that it is leſs proper, from its tendency to cake, and its not opening and uniting ſufficiently with the ſoils*.

But where, as well as theſe, there is likewiſe a want of vegetable matter, mixtures of calcareous marle or lime, and farm-yard dung, and ſuch compoſts as are formed by combining lime or chalk with light ſandy or gravelly earths; or lime and chalk incorporated with ſea-weeds and ſea-ſand, where they can be ſufficiently procured; would likewiſe be highly uſeful applications in theſe circumſtances. Peat aſhes are, in ſome places, uſed with ſucceſs; and gypſum, when mixed in a ſmall proportion with any of theſe vegetable products, would, probably, be found highly efficacious in this condition of clayey ſoils, where they are tolerably dry. This ſubſtance, as well as lime and chalk, may alſo be beneficially employed on ſoils of this nature that abound with acidity, in order to neutralize, and thereby correct the injurious properties of ſuch principles.

Moſt of theſe modes of improving clayey ſoils are practiſed with ſucceſs in one part or other of the kingdom. In Scotland, where lime is probably more employed on clayey ſoils, eſpecially thoſe of the better cultivated ſorts, than in England, they commonly apply dung the ſame ſeaſon that the ground is limed, but not in combination with it; by this method the lime is ſuppoſed to operate more powerfully, and with much greater expedition, than when uſed in the way of compoſt. Chemiſtry has ſufficiently demonſtrated, that lime in its active ſtate has great effect in promoting the ſolution of vegetable ſubſtances, and conſe-

* Kirwan's Eſſay on Manures.

quently of greatly augmenting the quantity of that kind of matter in ſoils. In this manner the quickneſs of its effects may be eaſily accounted for where, in ſuch caſes as that juſt ſtated, a large maſs of vegetable materials is immediately placed in contact with it. It appears, however, probable, that where theſe matters are employed in this way, the beneficial effects expected from them will not be ſo permanent or durable.

Theſe means of improving the condition of different ſorts of clayey ſoils may be greatly augmented, and aſſiſted by a judicious and well-conducted ſyſtem of tillage. The ploughings and harrowings on theſe ſoils, eſpecially where they are very tenacious and ſtubborn, ſhould be more frequently repeated; and at ſuch ſeaſons of the year as they are not too dry and cloddy, or too wet and pouchy, in order that they may be well broken down, and ſufficiently expoſed to the operation of the atmoſphere, and thus acquire a conſiderable degree of fineneſs, by which the growth of plants is much promoted. When the ſeed is put in, the harrowing ſhould be performed in ſuch a manner as to cover it very perfectly. The depth of ploughing on ſuch ſoils muſt be regulated by the circumſtances of the caſe, and the particular ſituation of the ground. Where they are thin and have a gravelly ſubſoil, and are liable to be injured by their proximity to ſprings of water, it ſhould not be ſo deep as where they have a better ſtaple, and are leſs in danger from water below them.

As moſt of the ſoils of this claſs, from the nature of their conſtituent principles, muſt be more retentive of moiſture than thoſe of ſeveral other kinds, it is highly neceſſary, eſpecially in the winter ſeaſon, that every method be taken to keep them as dry as poſſible. This is not leſs requiſite in reſpect to the lands that are in the ſtate of paſture, than thoſe that are under an arable ſyſtem of huſbandry, as the ſtagnation of much water is equally injurious whether the crops be corn, roots, or graſs. Beſides, where ſuch ſoils are in a ſtate of aration, by proper attention to ſuch means, they may at a more early period in the ſpring be in a better and more fit condition for the plough, and the reception of the ſeed, by which the danger of the crop, of whatever kind it may be, being inconvenienced by too much wet or dry weather, will, in a great degree, be avoided; as when this ſort of ſoil has once been well broken down and reduced by the different operations of harrowing and rolling, and the ſeed put in, it ſeldom ſuſtains any injury from the dryneſs of the ſeaſon afterwards*.

In the tillage of ſoils of this deſcription, from their ſtiff nature, it will likewiſe

* Donaldſon's Modern Agriculture, vol. I. p. 161.

always be neceffaryto have the implements that are made ufe of, of more ftrength than in other cafes, and to have the animals that are employed in drawing them fo attached as that they may do as little injury as poffible by their treading. On this account, in ploughing fuch lands it may be moft advifable to have recourfe to fuch kinds of ploughs as admit of the horfes drawing fingly, and following each other in the bottom of the furrows*.

In the fallowing of clayey foils, it is alfo neceffary for the farmer to attend to the particular ftate of the feafon,and not break up or ftir them when they are very dry or very moift, as in either cafe he muft obvioufly perform the bufinefs to great difadvantage; but to choofe, as much as poffible, proper regard being had to the nature of the crop that is to be put in, fuch times as that the ground is neither too dry and hard, fo as to be ftirred with great labour and difficulty, or too much impregnated with moifture, fo as to render it very adhefive and poachy.

In afcertaining the nature and goodnefs of clayey foils, much affiftance may frequently be derived from an attention to the afpect of the different forts of trees, and the appearances of the various crops; as where particular kinds of trees, fuch as the oak and elm, and hedge plants of various kinds, are in a ftate of luxuriant growth, and where the grain and other vegetable crops, as well as the grafs lands, are in a healthy, vigorous, and flourifhing condition, favourable conclufions may be made; but where the former have a ftunted, unhealthy appearance, and do not grow with vigour, and the latter are thin and fhort, they may be decided to be poor and unfriendly for the purpofes of vegetation†.

LOAMY SOILS.

Soils of this defcription, as characterifed by agricultural writers, are, probably, much too numerous; yet, from their being compounded of very different forts of materials, they, undoubtedly, admit of confiderable variety. The fubftances that are moft commonly found to contribute to the formation of loamy foils, are clay, fand, gravel, and chalk. Sometimes an oxyd or calx of iron is alfo found blended with them in a fmall proportion. In proportion as the argillaceous or clayey principle diminifhes, they recede from the nature of the clayey foils; confequently the nearer the quantity of that fubftance

* The fwing-plough anfwers very well for this purpofe.

† Bannifter's Synopfis of Hufbandry, p. 2.

approaches to that of the others, the ſtronger and more heavy will the loamy ſoil be. The differences in the lightneſs and friability of the ſoils of this claſs, in a great meaſure, depend on the relative proportions of the other ingredients. Where the calcareous ingredient greatly exceeds thoſe of the ſandy or gravelly kinds, they are neither ſo light nor ſo pulverizable as where they are nearly equal, or where the ſandy or gravelly matters conſiderably predominate over it. In the latter caſe, indeed, ſuch ſoils are formed as have been denominated by practical farmers *light and hungry*, eſpecially where the earthy bed or ſtratum thus produced, is but of little depth, and reſts on a gravelly or flinty bottom or ſubſoil.

The variety in the colours of ſoils of the loamy kind, ſeems, in ſome inſtances, to be produced by the union or mixture of metallic ſubſtances in greater or leſs proportions, and in more cloſe or more lax ſtates of combination with them; in others, by the prevalence of acid impregnations. The colour in the firſt caſe is for the moſt part reddiſh, approaching to brown; in the latter it is commonly blueiſh, changing by heat to a ſlight red. But theſe are not the only cauſes that influence the colour of theſe ſoils; they are much altered in their appearances, as well as other qualities, by the different proportions of vegetable or animal matter which they contain, and the different ſtates of decompoſition and decay to which they have been carried by length of time, cultivation, and other means.

In ſituations where this ſort of ſoil has been but little diſturbed, and conſequently little changed by the artificial additions of either animal or vegetable ſubſtances, and thoſe which it naturally contained not having advanced to the ſtage of perfect ſolution and decay, it is generally found of a light brown or hazel colour; but where much culture has been employed for a length of time, and large applications of animal and vegetable matters frequently made, the natural and artificial materials of theſe kinds having proceeded more nearly to the ſtate of perfect reſolution and deſtruction, it has an appearance that approaches to that of black. From theſe various circumſtances the properties of the ſoils are likewiſe conſiderably altered and affected, as well as their colours changed.

This ſort of ſoil being leſs cloſe, compact, and adheſive, than the clayey, admits much more readily of amelioration and improvement. The more ſtiff and heavy kinds, in which the argillaceous and calcareous principles are the moſt abundant, and where the carbonaceous or vegetable principle is frequently deficient, the moſt appropriate and ſuitable means of rendering them

fertile and productive would feem to be the application of lime in the way of compoft or combination, with different vegetable and animal materials, fuch as farm-yard dung, blood, ground bones, and fimilar matters, and fuch earthy fubftances as contain large proportions of fand and gravel in different degrees of tenuity or finenefs. The quantities in which they are to be applied muft be determined by the particular circumftances and the fituation or ftate of the grounds. In general, however, thefe foils do not ftand in need of fo much of any fort of manure as thofe of the clayey kinds. Lime may fometimes be ufed alone, as where the land abounds with vegetable matters, and the calcareous principle is in too fmall proportion, and where there is a prevalency of acidity or fournefs in the foil, which is not unfrequently the cafe where it approaches the nature of clay. But in thofe foils of this nature, in which the calcareous and fandy or gravelly ingredients enter in fufficient proportions, good rotten dung, the vegetable matter produced from the decay of plants, and obtained by depofition from ftagnant water in ponds and other places, with feveral fimilar fubftances, may be ufed with the moft fuccefs; and where thofe bodies are too predominant, or in an over-proportion, fo as to render the foils over-light, a portion of clayey loam may be united with fuch fubftances with great advantage.

The loamy foils which are met with in extenfive diftricts on the banks or borders of the fea, and of large rivers communicating with it, are generally fo well conftituted and fo fertile, as to demand little improvement from manures. The principles which moftly abound in them are a fine fort of fand, calcareous matter in a high ftate of tenuity from the attrition or rubbing down of different kinds of fhells and other marine productions, and a rich matter proceeding from the diffolution of various luxuriant fea plants, and innumerable forts of animal exuviæ. Thefe alluvial materials are all gradually depofited and incorporated with the natural loamy earth of the regions or places in which they are found, and thus conftitute foils of the moft fertile and productive kinds.

From the foils of the loamy clafs being more friable and brittle, as well as more dry, than moft of the clayey ones, they are capable of being tilled with much greater eafe and facility, as well as much lefs ftrength of team, and at almoft every feafon of the year. And, on account of their property of receiving and tranfmitting moifture more freely, they are lefs apt to be indurated by too much dry, or chilled by too much wet weather. Befides, they are more influenced on expofure to the agency of the atmofphere and other external caufes, and thereby more adapted for the promotion and fupport of vegetation. And as they are found in moft cafes to be lefs difpofed to the production of weeds,

particularly thofe of the more injurious kinds, they can of courfe be kept clean with much lefs labour, and without the expenfive fyftem of management which is requifite on many other kinds of foil.

CHALKY SOILS.

Soils of the chalky or calcareous kind occupy very extenfive tracts of land in different parts of the kingdom, and are marked with confiderable diverfity, as proceeding from the nature, properties, and proportions of the calcareous matter as it exifts in them; the fubftances that are mixed and combined with it; the depth and qualities of the earthy ftratum which is placed upon it; and the difpofition of the fub-foil or bafis on which this is formed and depofited.

Calcareous matter is contained in many different ftony fubftances, befides that of chalk, as marble, lime-ftone, coral, and fhells of different kinds; and in ftates of union with other materials, fuch as fand, the different fimple earthy bodies, in different proportions, and in fome inftances with iron and magnefia. Its capability or powers of imbibing and retaining moifture is confiderable, though not fo great as that of clay. It burns to lime by proper degrees of heat, and abforbs carbonic acid gas or fixed air in different proportions from the atmofphere, and returns again to the ftate of chalk or effete calcareous matter. It is found of very different degrees of hardnefs and friability, as well as of different ftates of finenefs or pulverization, in different foils of the clafs to which it belongs. It varies alfo greatly in its effects in refpect to vegetation; from the different matters that may happen to be combined with it in its primitive or original ftate. It has long been known to the practical agriculturift, that fome forts of lime may be employed in large proportions; while others cannot be ufed, except in very fmall quantities, without doing very confiderable injury to the foil with which they are incorporated. The long unexplored caufe of this diverfity of effect in different limes, feems lately to have been placed in a more clear and fatisfactory point of view, by the experimental attempts of an ingenious philofopher*. He has found by repeated experiments, that that fort of lime which is the moft friendly to vegetation confifts entirely of calcareous earth, and quickly abforbs a large portion of carbonic acid gas or fixed air from the atmofphere; while that which is

* Tennant on the different forts of lime ufed in agriculture, in Tranfactions of the Royal Society, 1799, Part II.

injurious and unfriendly to the growth of plants contains only three parts of pure calcareous earth, the other two confifting of magnefia, and that it abforbs comparatively but an extremely fmall portion of carbonic acid gas or fixed air from the furrounding atmofphere. This kind or mixture of calcareous matter was alfo afcertained to be very flow in acquiring the power of fupporting vegetation, even after it had been converted into lime, and remained for a confiderable length of time in the ftate of mortar. The lime-ftone in which there is a mixture of magnefia, is much harder, and diffolves confiderably more flowly in acids than that which is purely calcareous. The fame author likewife fuppofes that the cryftallized ftructure commonly obferved in the magnefian lime-ftone indicates that it has not been formed by the accidental conjunction of the two earths, but conftituted by their chemical union. The difficulty with which it is diffolved by means of acids, may alfo, he thinks, in fome meafure, depend on the attraction of its different component particles to each other.

This fort of lime-ftone would feem to abound in different parts of the kingdom. It is obferved to extend for thirty or forty miles from a little to the fouth-weft of Workfop, in the county of Nottingham, nearly to Ferry-bridge in Yorkfhire. In the account of the agriculture of the midland counties, Mr. Marfhall obferves that the lime made at Bredon, in Derbyfhire, is hurtful to vegetation, when employed in large proportions; and our experimenter has found that it contains magnefia nearly in the quantity ftated above; but that the ftone in this inftance is frequently cryftallized in a rhomboidal form, and petrified fhells, not calcareous, but fimilar to the compofition of the ftone itfelf, are occafionally, though feldom, found in it. The different combinations of calcareous matters are fometimes found contiguous to each other. At Matlock, in Derbyfhire, it is ftated that the rocks on the fide of the river where the houfes are built are magnefian, while thofe on the other are calcareous; and that the magnefian rock appears to be incumbent on the calcareous ftratum, as in defcending a cave formed in this rock, a diftinct vein of common lime-ftone may be feen which contains no magnefia. The calcareous ftratum is very full of fhells, and there are alfo fome in the magnefian rock, but they are extremely rare. The practical diftinctions of hot and mild limes, which have frequently been made by thofe engaged in the improvement of foils, and which have been particularly attended to by a late writer *, prove that the magnefian calcareous matter is met with in the more northern counties: that which is confidered as

* Fenwick's Effay on Calcareous Manures.

hot being alfo found by him to be more difficult of folution in acids. Thefe important and interefting facts not only fhew that whatever famenefs there may be in the nature of calcareous matter when in its pure and unadulterated ftate, that as met with in foils, and different fubftances of the calcareous kinds, it has confiderable diverfity, and when in union with magnefia it is in a high degree prejudicial to the growth of vegetables.

Calcareous matter, whether it be in the effete or ftate of *carbonat*, or in the more active one of caufticity, as quick-lime, feems ultimately to promote the refolution and deftruction of vegetable and animal fubftances; in the latter ftate, however, it acts with much greater violence on thefe materials, deftroying their organization, and diffipating their principles more quickly, as well as robbing them more completely of the carbonic acid gas or fixed air, which is fo effential; while in the former it operates with great mildnefs, and only aids the refolution of thofe fubftances by gently promoting the procefs of putrefaction.

The proportions of clayey, loamy, and gravelly ingredients, which are conjoined with the calcareous matters of thefe foils, are various in different diftricts; where the argillaceous and loamy materials are comparatively in large quantities, foils of the heavier chalky kinds are formed, and where the fandy or gravelly are predominant, we have the lighter ones. There are alfo material differences proceeding from the earthy matter with which the calcareous ingredient is mixed in the ftate of foil. Where the quantity of this is fmall, and not reduced into any very perfect ftate of mould, the foil, as is evident, muft be poor and thin; but where the depth of this fuperficial ftratum is confiderable, and the animal, vegetable, and other fubftances, of which it is compofed, is advanced to a more complete ftage of decompofition and decay, the foils are more rich and heavy. Some variety is likewife caufed by the ftate of the under-ftratum or fubfoil. If it be compact and much intermixed with filiceous or flinty matter, or have a mortary hardnefs, it is lefs favourable than where it is of a more open, brittle, or powdery texture.

From what has been ftated, the means of improving chalky or calcareous foils muft be evident. As the calcareous principle is here abundant, the principal intention is the alteration of their textures, and the fupplying of vegetable matter. This is effected in the heavier forts of chalky foils, by the application of clayey and fandy loams, according to the particular circumftances of the cafes; and in the thinner or more light lime-ftone foils, it may be accomplifhed by means of clay, argillaceous marle, and the rich imperfectly decompofed vegetable matter

arifing from the depofition and accumulation of fuch fubftances in low, clofe, and wet fituations.

Farm-yard dung, and compofts of all kinds of dung, with good mould, will be advantageous. Soot and malt-duft have, likewife, in different inftances, been fuccefsfully employed.

Where mifchief has been experienced from the too great abundance and prevalence of magnefian lime, or calcareous matter, the plentiful ufe of afhes produced from the combuftion of frefh vegetable fubftances, would feem to be the moft fuitable application as a remedy.

Whatever appearances of lightnefs there may be in chalky foils, they require confiderable ftrength in the team, where the ftaple or earthy ftratum of the lands will admit of their being wrought to a tolerable depth; but where there is a thinner furface of earthy materials, lefs force of draught will be requifite. In the latter cafes, the foil is, however, far more precarious and uncertain, as well as much lefs productive in refpect to the crops that are cultivated upon it, than in the former. As chalky foils are not fo liable to be injured by water as others, the bufinefs of tillage is much lefs impeded from that caufe; but a dry feafon fometimes renders them fo hard as to be totally incapable of being broken up, until they have been moiftened by the falling of a confiderable quantity of rain. From the great wear, by friction and other caufes, that takes place in the ploughing and breaking up of moft foils of this clafs, the ftate of the irons of the ploughs, or fuch other inftruments as are employed, muft be more frequently and more particularly attended to, as from the neglect of this circumftance much inconvenience, as well as lofs, may arife to the farmer.

SANDY SOILS.

Sands feem to have been gradually formed by the attrition and rubbing down of the various folid fubftances that are found in nature, efpecially fuch as are of the filiceous, calcareous, and ftony kinds, and are of different degrees of finenefs as they approach the fize of gravel. They are alfo met with of various colours and appearances in different regions or tracts of country, fuch as white, dufky brown, yellow, and red. Thefe differences, as well as thofe which refpect their weight, tenacity, and other properties, depend on the nature and proportions in which many other forts of materials enter into combination with them.

Where the proportions of clayey, loamy, or other earthy fubftances with which they are mixed, approach nearly to that of the fand, the heavier forts of fandy foils are formed; but where thefe enter only in very fmall quantities, we have the light fandy foils; and where they are hardly met with at all, the foil is a loofe blowing fand, moft commonly of a white or brownifh appearance. The portions of vegetable matters that are intermixed with different foils of the fandy kind are not lefs various than thofe of the clayey and loamy, from which confiderable differences of quality are produced. Thefe differences in their textures and compofitions, alfo introduce others which refpect their powers of admitting and retaining heat and moifture. The opennefs and want of adherence in fuch foils, while they allow of the admiffion of heat and water more readily, permit them to be carried off with greater eafe and expedition, they are therefore lefs permanently benefited by their influence than many of the clofer and more adhefive foils.

From this view of the conftituent principles of fandy foils, it is obvious that they are chiefly deficient in the calcareous, argillaceous, loamy, and vegetable ingredients. The intention of the agriculturift fhould, therefore, for the moft part be directed to the augmentation of their cohefive property, and the fupply of the calcareous and decayed animal and vegetable matters. With a view to the firft, argillaceous and loamy materials may be had recourfe to; and it has been obferved by an able and intelligent writer*, that a lefs proportion of clay is required in the improvement of light fandy foils, than of fand in clayey ones; but whether this rule be generally correct or not, fome of the thinner and poorer forts of fandy foils certainly demand large proportions of the argillaceous ingredient. Where the calcareous principle is in fufficient abundance, argillaceous marle and clayey loams are the moft fuitable; but where it is deficient, calcareous marles and loams will be more advantageoufly employed. On thefe principles it is, that in the counties of Suffolk, Norfolk, York, and fome diftricts of Scotland, experience has fhewn the former to be more beneficial; while in other places, as the Ifle of Wight, the diftrict of Caermarthen in Wales, in the counties of Suffex, Chefter, and Stafford, in England, and the northern parts of Scotland, the latter has been found to produce the moft advantageous effects on fandy foils.

The defect of vegetable matter in thefe foils may be remedied by the ufe of farm-yard and other compofts, proceeding from animal and vegetable fubftances

* Fordyce's Elements of Agriculture, p. 89.

in a ſtate of putrefaction. But good earth, or mould, and the imperfectly reſolved matter found in boggy ſituations, may alſo in many inſtances, where theſe cannot be eaſily procured, ſupply the deficiency in a very beneficial manner.

The folding of ſheep upon ſoils of this nature, likewiſe, contributes greatly to their improvement, not only by the quantity of dung and urine that is depoſited upon them, but the conſolidation and firmneſs of texture that is produced by their treading.

All theſe different ſorts of materials may be applied either alone or combined with one another in the form or ſtate of compoſts. The marles and clayey ſubſtances are, however, for the moſt part, laid on in the ſtates in which they are found; but the farm-yard dung, and peaty matter, often in mixture with each other, or with ſubſtances of other kinds, ſuch as thoſe of an earthy nature: the peaty earth may alſo frequently be uſed alone, when applied to the ſurface of paſture lands.

The light, open, and porous texture of ſandy ſoils, renders them much more eaſily cultivated and kept in order than thoſe of the ſtrong and cloſe kinds; conſequently the farms where they prevail are generally large; and when properly prepared they are better adapted for the growth of many ſorts of crops, ſuch as thoſe of the bulbous and tap rooted ſorts. They have alſo another advantage, which is that of puſhing forward the crops with more expedition. Whatever inconveniences attend them, are moſtly ſuch as proceed from the want of a ſufficient degree of coheſion among their conſtituent particles and ſolidity of texture. On theſe accounts they often counteract the beſt and moſt judicious management. The roots of the crops are liable to become naked and expoſed from ſtorms and various other cauſes; and if grain, to fall down and be lodged ſo early in the ſeaſon as to render them of little value.

GRAVELLY SOILS.

In the ſtate of gravels which contribute to the formation of this claſs of ſoils, there is a variation of ſize in the pieces or particles of which they are compoſed, from that of a very ſmall pea to the largeſt cockle. Where they become of ſtill larger dimenſions they are termed ſtones or rocks, according as they are in ſmall portions or large maſſes; and the ſoils are then ſaid to be ſtony or rocky, as the circumſtances of the different caſes may happen to be.

The beds of gravel, whether they be of the larger or ſmaller kinds, are moſtly

either of the ſiliceous or flinty nature, or of the calcareous or chalky; but the ſtones and rocks are of very different kinds. With theſe diſſimilar ſubſtances, ſome others in different ſtates of reduction and pulverization are blended and united in various proportions, ſo as to conſtitute gravelly ſoils that differ conſiderably in their textures and other properties. The chief of theſe are loams, and the mould or earthy matter formed by the deſtruction and decay of numerous animal and vegetable ſubſtances.

The gravelly mixture is ſometimes alſo found to approach nearly to the ſurface, while at others it recedes conſiderably from it*. In ſome inſtances ſprings riſe immediately underneath; in others they are at a great depth. The bottom, or ſub-ſoil, is likewiſe various; in ſome caſes it is ſtony and rocky, in others it is clayey, or a rocky gravel, and ſometimes ſand, &c.

The open porous nature of gravelly ſoils diſpoſes them to admit moiſture very readily, as well as to part with it with equal facility; from the latter of which circumſtances they are ſubject to burn, as it is termed, in dry ſeaſons, which is not the caſe in the heavier or more retentive ſort of ſoils.

The defects in the conſtitution of gravelly ſoils may be removed by the applications of one or other ſorts of marle, where they can be procured, according to the circumſtances of the caſe. Where the gravel is of the calcareous kind, clay, or clayey loam, may be moſt properly made uſe of. And a mixture of the carbonate of lime, or lime in its effete ſtate, and clay, would ſeem to admit of a pretty general application to theſe ſoils. Chalk, as being of the ſame nature, may alſo be made uſe of in the ſame way. Indeed for theſe kinds of gravel, which from their contiguity to ſprings are apt to lie wet in the winter, there is no manure more properly adapted than chalk; which, although it does not abound with vegetable matters in any large proportion, like yard dung, and ſome other dreſſings, is, however, an excellent preparative for them, and will, in ſome meaſure, ſupply the place of ſuch ſubſtances. From its abſorbent nature, it is of good effect not only to counteract the ſuperabundant moiſture of ſuch ſoils, but to leſſen their heat; by which means the diſpoſition to burn in the ſummer, ſo inimical to the growth of various crops, and to which all gravels are in ſome degree liable, is prevented; and in this laſt view chalk, though particularly

* It is obſerved by Mr. Middleton, in his excellent Report of the Agriculture of the County of Middleſex, that "when the gravel is very near to the top, a full crop of yellow-bloſſomed broom covers the ground, if in a ſtate of graſs, and when ploughed an equally full crop of ſorrel." This he remarked in the old incloſures, and on ſeveral places on Enfield-chaſe.

adapted to thoſe of the wet and ſpringy kind, may be applied with ſucceſs on gravels of almoſt every denomination *.

The deficiency of the vegetable and animal earthy matters, where it exiſts, may be properly ſupplied by dung of the farm-yard kind in its more rotten ſtate, and various animal excrements. Theſe are frequently applied to the gravelly ſoils, with the greateſt effect and advantage, in the form of compoſts, with good loamy mould, aſhes, the mucilaginous and clayey depoſitions of rivers and ponds, and other ſubſtances of a ſimilar kind. Several of theſe materials, and ſome others of the animal claſs, are, however, often uſed ſeparately to the ſurface of ſoils of this ſort.

Soils of this deſcription may alſo be much improved by a judicious variation of the green vegetable and other crops that are cultivated upon them.

Gravelly ſoils, from the lightneſs of their texture, and their not affording great reſiſtance, except where the ſtones are large, or there are rocks, are not expenſive or difficult in the means of cultivation. All the neceſſary buſineſs of this ſort is capable of being carried forward with much eaſe and expedition, and the lands are, in general, ſoon brought into the proper ſtates for the reception of crops.

PEATY OR MOSSY SOILS.

These ſoils are met with in pretty extenſive tracts in many parts of the kingdom. In ſome places, in England, they are provincially denominated moory, peaty, and heathy ſoils; in Scotland, they are more commonly known by the title of moſſy; and in Ireland, they receive the name of boggy ſoils. They differ, like all the other kinds of ſoils, from the nature of the ingredients of which they are conſtituted or compoſed, and the proportions in which theſe are found to prevail in them. Where the vegetable or peaty material predominates but little over the other ſubſtances with which it is mixed and incorporated, the lighter ſorts of peaty, moory, or heathy ſoils, are formed; but where the other matters bear only a ſlight proportion to it, the deep and heavy, peaty or moſſy, ſoils preſent themſelves. In different diſtricts the peaty matter is found of different depths, and of various degrees of denſity or cloſeneſs of texture, probably proceeding from ſome original differences in the vegetable ſubſtances from which it was formed, or the greater advances which it has made to the ſtate of perfect de-

* Banniſter's Synopſis of Huſbandry, p. 13.

compofition or decay. The fub-foil in moft of the deep moffy diftricts is of the clayey kind, more or lefs ftiff and heavy, over which the peaty or moffy material is depofited, generally in a fort of ftratified order; the firft layer of which being commonly not more than ten or twelve inches in thicknefs, exhibits the appearance of a richifh brown earth, in all probability from the incorporation of the loamy or clayey matters, with the peat or vegetable earth, lying immediately upon them, and conftituting, originally, perhaps, the furface of the ground. The layer that fucceeds to this is moftly of a dark colour, and confiderable thicknefs, apparently formed of a great variety of vegetable or other materials in the more perfect ftages of refolution and decay, united together by time and other circumftances with more or lefs compactnefs and folidity. The uppermoft ftratum, or that which is placed upon this denfe, peaty matter, is, in general, of a very pale colour, and very light fpongy texture, arifing poffibly from the graffes, leaves, and other vegetable fubftances, of which it is formed, not having attained that ftate of decay which conftitutes the darker forts of peaty earth.

But in the more fuperficial peaty foils, little or nothing of this ftratified appearance is met with. A coat of peaty earth, differing greatly in thicknefs according to the peculiarity of the fituations, and other circumftances, is formed by a great length of time from the deftruction and decay of fucceffive crops of graffes, leaves, and fubftances of the heathy or other kinds, and depofited upon, and intermixed with, the various harder materials of the foils which happened to be underneath them. By thefe means much variety is produced in the foils. Where the under-ftrata of earthy matter are tolerably good, and the crops of vegetables large and luxuriant, the better forts of light peaty foils feem to be predominant; but where the quality of the under-ftrata are indifferent, and the vegetable products fcanty, as well as feeble in their growth, and principally of the heathy tribe, the poor peaty and heathy, or moory foils, are met with.

All peaty foils feem to be thus gradually formed by the depofition of vegetable matter, fupplied by the diffolution and decay of aquatic and other plants that grow in low moift fituations, as well as fubftances of other kinds brought down by water, from the high grounds in their neighbourhood, in the ftates of folution and diffufion, and gradually depofited from it on its becoming in a ftate of ftagnation, by means of obftructions and ftoppages proceeding from different caufes.

From the nature of the compofition of thefe foils, it is obvious that they muft be very retentive of water, efpecially where they are of any great depth; hence

they feldom or ever become free from the exceffive quantities of moifture, with which they are loaded in the rainy feafons. An able author juftly obferves, that from the rays of the fun and drying wind being exerted during the fummer feafon in carrying off, by means of evaporation, the fuperabundant moifture in fuch cafes; and heat being known to be abftracted from bodies, and cold generated thereby, effects muft be produced highly injurious not only to climate but vegetation in general, and more particularly to fuch plants as ftand in need of a higher degree of heat, and more nourifhment, than fuch foils are capable of fupplying.

And he thinks that there can be very little doubt but that thefe prejudicial effects on the growth of vegetables extend themfelves to the more dry lands adjoining fuch fens or deep moffes *.

The furface-ftratum of peaty foils, from its being more expofed to the influence and action of the pure air of the atmofphere, is, it is alfo obferved, much lefs foluble than the under-ftrata, confequently in its fimple or unmixed ftate lefs proper for the purpofes of agriculture. From the fame caufe too, it becomes lefs capable of fupporting flame, and is therefore improper for the purpofes of fuel.

From what has been obferved refpecting the compofition, formation, and properties, of peaty foils, it is evident that they muft require different methods of management, in order to reclaim and render them fuitable for the growth of the various forts of vegetables that are objects of hufbandry.

In the deep moffes, the firft thing to be attempted is to draw off, as much as poffible, the fuperabundant moifture, by the cutting of proper drains, and fuch other means as the nature of the fituation, and other circumftances, will admit of. In places where water in fufficient quantity can be conveniently made to pafs through fuch moffes, and where the foil underneath is good, much may be effected by floating away the principal part of the moffy fubftance; but where the moffes are not deep, or the foils under them of a good quality, after the making of proper drains, the beft way is, probably, to ridge them in fuch directions and modes as are the moft effectual in promoting the exit or paffage of the ftagnant water which they contain. Different materials may then be applied with the intention of improving their textures, and promoting the diffolution of the undecayed parts of the vegetable matters that are contained in them. The firft may be accomplifhed by the application of various gravelly fubftances, fand, and coarfe earth; and the latter, efpecially where there is a large growth of heath and other

* Dundonald's Connection of Agriculture with Chemiftry, p. 33.

coarſe plants, by the uſe of lime in its active or cauſtic ſtate: but where ſuch plants do not ſo much abound, alkaline ſubſtances, chalk, calcareous marle, the ſhelly kinds of ſea ſand, and the carbonate of lime, may be more advantageouſly had recourſe to.

Shell marle, chalky ſubſtances, rich clays, and lime-ſtone gravels, being frequently met with under deep peat moſſes, proper inveſtigation ſhould conſtantly be made by means of boring them in various parts; as in caſe any of theſe materials can be diſcovered at a ſuitable depth, ſuch grounds may be brought into cultivation much more cheaply and conveniently, from their being applied more readily to the ſoft ſpongy ſurfaces of ſuch ſoils, than where they are under the neceſſity of being carted upon them from conſiderable diſtances. Paring and burning is uſeful in both the above views, where the quantity of vegetable matters on the ſurface is conſiderable, and of the coarſe kind; but the method of applying good earthy matter is to be preferred, where it can be procured in an eaſy and not too expenſive manner.

Something may likewiſe be effected in the way of promoting the fertility of theſe ſoils by cropping with particular ſorts of vegetables. Thoſe that have large branching ſtems, and which cover the ſurface of the ground very much, thereby excluding the action of the air in a great meaſure upon it, are conſtantly to be employed as the moſt advantageous and uſeful.

VEGETABLE EARTH OR SOIL.

This kind of earthy material conſtitutes the ſuperficial bed or ſtratum, in which plants, for the moſt part, vegetate, in every ſort of ſoil; and differs very much in different places, from the variations that take place in its depth, and the greater or leſs progreſs that has been made in the ſeveral ſubſtances of which it is compoſed to the ſtage of perfect decompoſition or decay.

Some variety may, likewiſe, be cauſed by its being more intimately or more looſely mixed and blended with the other bodies that are found in ſoils. It ſeems probable, too, that the earthy matter which is formed from the deſtruction of ſome ſorts of vegetable ſubſtances may be better ſuited for the purpoſes of vegetation than that which proceeds from others.

Vegetables, from their containing a conſiderable portion of mucilaginous matter in a ſtate of mixture with their other ſubſtances, become, in ſome meaſure, capable of ſolution in water, though the external ſurfaces of living plants, on account of the reſinous and animalized materials that enter into their com-

poſition, are protected from its operation. From the former circumſtance, and that of earthy matters being contained in them, which had been taken up in the ſtate of ſolution with their freſh juices while growing, it is evident that large quantities of vegetable mould muſt be continually formed and depoſited on lands by the natural decay of ſuch ſubſtances.

But the formation of vegetable mould or earth is farther effected by means of the putrefaction or diſſolution of ſuch vegetables as are cut down, or otherwiſe deſtroyed, on the ſurface of the ground, and the application of various kinds of dung and compoſts. Where theſe have been in great abundance for a long time, there is moſtly a deep rich ſurface ſoil of this earth; but where few vegetable products, and thoſe of the leſs luxuriant kind, have been left to undergo the above proceſs, or little aſſiſtance given by means of manures, the cruſt of ſurface mould is generally thin and poor. The reſolution of vegetable matters is greatly promoted by a proper degree of moiſture and heat, as well as a ſuitable ſtate of the air.

In the proceſs of the putrefaction of theſe ſubſtances various chemical changes take place;—the water which they contain is decompoſed; there is an abſorption of the pure air of the atmoſphere; heat is diſengaged; and new combinations of the gaſſeous and ſaline kinds are formed. By theſe changes many ſubſtances are, therefore, converted to the uſe and ſupport of vegetable life, that could not have been applied by any other means; beſides, they are rendered much more extenſively applicable than they could otherwiſe have been, for that purpoſe.

The abſorption of pure air from the ſurrounding atmoſphere, or the proceſs of oxygenation, is conſidered, by a late writer, as the chief cauſe of the retention of vegetable matter on the ſurface of the earth, in deep peaty ſoils, and moſt others, but eſpecially thoſe that have been long in a ſtate of tillage. The vegetable matter by this means being rendered leſs deſtructible, ſcarcely any of it is carried away in a diſſolved ſtate by rains, or the application of water in other ways, conſequently accumulation muſt take place, which, under other circumſtances, could not have been the caſe*. The vegetable materials contained in ſoils, therefore, from their admitting different degrees of this proceſs,

* The Earl of Dundonald, in his treatiſe On the Connection of Agriculture with Chemiſtry, obſerves, that "to this proceſs of oxygenation, the continuance of vegetable matter on the ſurface of the earth is principally to be aſcribed; as in the caſe of peat moſſes, fens, and moraſſes, as well as in moſt ſoils, but more eſpecially in ſuch as have long been under cultivation. The indeſtructible ſtate of vegetable

and thereby becoming more or lefs infoluble, poffefs different powers in promoting the growth and nourifhment of plants. Where they have been expofed to the action of the oxygenous or pure part of the air, for a confiderable length of time, they are much more infoluble, than where this has been the cafe for only a fhort period.

In order, therefore, to promote the formation of vegetable earth or mould, recourfe muft not only be had to fuch fubftances as accelerate the putrefactive procefs, but alfo fuch as have a tendency to increafe the folubility of the vegetable mould or foil itfelf. The firft of thefe purpofes may be accomplifhed by the application of fuch materials as have been found ufeful in changing vegetable fubftances into the ftate of mucilage, fuch as the carbonate of lime, or effete lime, marle, chalk, and calcareous matters in general, and alfo fome earthy faline fubftances, as the refufe of falt manufactories, &c. The latter is to be attempted by the ufe of different alkaline fubftances, fuch as the afhes produced by the burning of various green vegetable materials, the urine of animals, the liquor of dung-hills, night-foil, and other animalized matters.

Vegetable mould may, likewife, be augmented by many other means; fuch as the growth of thofe kinds of crops that cover the ground much, and thereby produce a ftagnated ftate of the air; the confuming upon the ground or the turning down of rich, full, and fucculent forts of green crops, by which a large portion of vegetable matter is quickly brought into the ftate of decay; and the deftruction and evacuation of various forts of infects that are prevalent in foils, by the application of fubftances of different kinds.

matters, under thefe circumftances, and their conftant accretion, may," he thinks, "be referred to the infoluble compounds, produced by the action of pure air on thefe inflammable fubftances.

"The infolubility, to a certain degree, of this fyftem, adopted by nature, is undoubtedly," fays he, "to be preferred to one more completely foluble; for it is evident, that if putrefaction, or oxygenation, had poffeffed the power of rendering all the vegetable matter, by a fpeedy procefs, foluble in water, two pernicious confequences muft have followed: The rains would have wafhed down fuch extracts, and foluble matters, as faft as formed, into the rivers and fprings, contaminating the waters, and rendering them unfit for the exiftence of fifhes, or for the ufe of terreftrial animals. The fea, in procefs of time, would thereby receive all the vegetable and animal produce of the dry land, and the earth would ultimately become barren, confifting alone of the fimple earths, without any admixture of vegetable matter; confequently there could be no accumulation of this fubftance on the furface, as is the cafe, to an immenfe degree, at prefent. As fuch there cannot," he conceives, "be a doubt, but that the prefent incomplete procefs of putrefaction, oxygenation, or folution of organic bodies, has been eftablifhed by the great Creator of all things for wife and benevolent purpofes; efpecially when it fhall be underftood, that the apparent imperfections of this (to a certain degree) infoluble fyftem are, as they refpect agriculture and vegetation, to be remedied, when neceffary, by the ingenuity and induftry of man."

It is obferved by the able author juft mentioned, that a fuperabundance of vegetable matter in foils, efpecially where it is much expofed to be acted upon by the oxygen or vital air of the atmofphere, is apt to render the ground too loofe and open in its texture for the growth of moft forts of grain; winter corns in particular, from the fudden alternations of froft and thaw, being frequently thrown out of fuch foils and deftroyed. Where this is the cafe, great benefit may be derived from the ufe of various faline matters, and lime in its effete ftate, as by fuch means the vegetable parts of the foil will be reduced to their proper and moft productive ftate*.

* Dundonald on the Connection of Agriculture with Chemiftry, p. 175.

ECTION VII.

MANURES.

MANURES—Changes undergone in Subſtances in the Formation of—Fluid, elaſtic, and volatile Matters chiefly prepared in the Soil—Are in different Proportions according to Circumſtances—The more groſs Matters applied to Lands chiefly termed Manures—Changes neceſſary in theſe to fit them for the Support of Vegetation—Much Difference in, according as they abound with certain Subſtances or Principles—This probably the Cauſe why ſome Matters are ſo ſuperior to others when uſed equally—Other Modes in which they contribute to the Growth of Crops—Difficulty of Arrangement of—May probably be uſefully divided into Animal, Vegetable, Foſſil, Saline, and Compound Manures.—MANURES FROM THE DECOMPOSITION OF ANIMAL SUBSTANCES.—How they contribute to the Support of Plants—Differences in the conſtituent Principles of, may produce Differences in the Effects of—Their Tendency to Putrefaction—How promoted—Circumſtances to be attended to in.—Hard animal Subſtances.—Different Natures of—Bones, Horns, Hoofs—Circumſtances to be attended to in their Preparation, Mixture, Combination, and Application.—Soft animal Subſtances—Various Kinds of—Greaves, Sugar Scum, Refuſe of Manufactories— Fiſh, Blood, &c.—Different Natures of—Circumſtances to be regarded in the Preparation of—In the Combination and Mixture of, with other Matters—In the Application and Uſe of.—Animal Dungs—Nature and Goodneſs of—On what it depends in general—Kinds of employed—Effects of, how produced—Night-ſoil—Of Birds—Of Horſes and Cows—Of Sheep—Circumſtances to be attended to in the collecting of—In the mixing of, with other Subſtances—In the Application or Uſe of, on Land.—MANURES FROM THE DECOMPOSITION OF VEGETABLE SUBSTANCES—Methods in which they are prepared for the Support of Plants—Different Matters ſuitable for, formed during the Decompoſition of—Reaſons why they differ in their Effects on Land—Subſtances that may be uſed, various—Manner in which they may be rendered uſeful—Refuſe Vegetable Subſtances—Green Crops—Sea Weeds—Tanner's Bark—Mud from various Places—Malt Duſt—Refuſe of Oil-cakes, &c.—MANURES FROM THE AGENCY AND DECOMPOSITION OF FOSSIL SUBSTANCES—Calcareous Matter in general—Lime or calcined calcareous Matters---Reaſon of the different Effects of, in different Caſes---Why it may vary, when prepared from different Subſtances---Effects of in its active State, or that of Quick-lime---In its effete State, or that of Carbonate of Lime---From its Combinations with different Subſtances---From its containing Phoſphorus.—Lime-ſtone—May be employed as a Manure without Calcination—Manner of preparing it for Uſe in this State—Different Effects of when thus applied—Soils on which moſt uſeful.—Lime-ſtone Gravel—Manner of rendering it more generally uſeful.—Chalk—Nature of—Mode of uſing it with the greateſt Chance of Succeſs—Effects of, on various Kinds of Soil—Proportions in which applied on each Kind.—Marle

—Different Kinds of, noticed—Manner of ascertaining them described—Agree in some Properties—Manner in which they should be applied in different Cases—Proportions in which they may be employed—Used on tillage and grass Lands—Circumstances to be attended to in their Application in each Case—Particulars to be regarded in repeating the Application of.—Sea Sand—Utility of, as a Manure—Soils on which it may be employed—Quantity of used—Mode of Application.—Common Sand—Nature of—How it may be useful on Land.—MANURES FROM THE AGENCY AND DECOMPOSITION OF SALINE SUBSTANCES—Different Sorts of, may be used—Modes in which they produce their beneficial Effects—Nature of particular Substances explained---Bleachers' Refuse---Soap-boilers' Waste---Vegetable Ashes---Coal Ashes---Circumstances necessary to be attended to in each---Mode of employing them—Advantages resulting from the Application of, in different Cases.---Soot---Modes in which it may be useful as a Manure---Manner of applying it---Reasons why Substances containing saline Matters should be preserved in Sheds.---Muriat of Soda, or Sea-salt---Utility of, as a Manure, not well ascertained---How it may promote Putrefaction---Other Ways mentioned in which it may be usefully employed.---MANURES FROM THE COMBINATION OF DIFFERENT SUBSTANCES---Farm-yard Compost---Nature of Substances from which formed—Means of promoting the Formation of---Manures may frequently be used with more Advantage when combined than in their simple States---Circumstances necessary to be regarded in the mixing of---Manures much increased in this Way—Cautions to be regarded in using different Substances—Lime in its different States, alkaline, saline Matters---Quantities of such Manures necessary to be applied to Land in different Cases-- Circumstances that must be attended to in their Use in this Way.---MEANS OF AUGMENTING AND PRESERVING MANURES—Waste of all Sorts of Substances to be prevented—To be reduced more quickly into the State of Manure—Attention to the Form and Construction of the Farm-yard necessary—Form of, described—Manner of proceeding with different vegetable Matters in—By mixing of Lime with—By preventing Evaporation—By collecting different Sorts of Materials---By folding Sheep---By managing different Green Crops—By preventing the Waste of the Soil of Privies---By Attention to the saving of different animal Matters---By collecting vegetable Earth---By the proper Management of Dung-hills-- Various Circumstances in respect to the Management of each, described.---GENERAL APPLICATION OF MANURES---States of, in which they may be applied with most Advantage---Modes of in different Cases---To arable Lands---To grass Lands---Seasons in which the Application of may be best performed, in different Instances---Circumstances respecting their putting into Land, described---When applied on the Surface, what necessary to be attended to---Means of applying them in the most saving Way---Kinds of Manure that may be used to most Advantage, in different Cases.

FROM the changes that are constantly taking place among bodies in nature, and the new combinations which are formed in consequence of them, a great variety of matters are unfolded, elaborated, and prepared for the nourishment and support of vegetable life.

Some of the substances which contribute in this way possess considerable fluidity

and volatility, ſuch as water, and various gaſſeous materials, as oxygen, hydrogen, azote, and carbonic acid, in different ſtates of combination * ; and are chiefly formed and applied in the ſoils on which the plants exiſt or grow, and in greater or leſs proportions, according to the ſeaſon of the year, the nature of the climate in regard to heat or cold, and the ſtate or ſituation of the grounds in reſpect to its qualities; while others are more groſs and heavy, and require to be applied and incorporated with ſoils, or ſpread out upon their ſurfaces, in order that they may produce their effects in promoting vegetation. It is principally to theſe, as being the means of ſuſtaining different ſort of plants as crops, that the term *manure* has been given by practical writers on agriculture, though it is extremely obvious that they muſt undergo different changes, and be reſolved into their more elementary principles, before they can be taken up and contribute to the increaſe and ſupport of vegetables. In the various materials which the art and induſtry of mankind have rendered capable of being beneficially employed in this manner, there is great diverſity; ſome are found to yield the matters which are neceſſary for the ſupport of plants much more readily and more abundantly than others, as animal, vegetable, and all ſuch ſubſtances as are rich in mucilage, ſacharine matters, and calcareous earth, and readily afford carbon, phoſphorus, and ſome aërial fluids, ſuch as have been mentioned; while others that are greatly deficient in all or many of theſe principles, or do not readily part with them, are found to be of much leſs utility, when employed in the way of manures. This is probably a principal reaſon why ſome ſorts of manures, or ſubſtances, when put upon grounds, are ſo greatly ſuperior to others, uſed at the ſame time, and in the ſame manner and proportion, a circumſtance which is frequently noticed in the practical details of huſbandry.

There are, however, many other ways in which ſubſtances, when applied to ſoils, may render them more fertile and productive, and contribute to the aid of vegetation. Some, beſides furniſhing ſuch matters as are ſuitable for the purpoſe of promoting the growth of plants, are known to add conſiderably to the quantity of vegetable and other matters contained in the ſoils on which they are placed, and thereby provide a more ſuitable and convenient bed for the reception of the roots of plants; others contribute little in this way, but operate chiefly upon ſuch materials as are contained in them, breaking down their organization or texture, and thus ſetting at liberty different volatile and other ingredients, by which new compounds are formed, and brought to ſuch ſtates as are the moſt

* Light, heat, and probably electricity, are alſo neceſſary to the growth of plants.

adapted to the ſupport of vegetable life; others again act principally by producing certain changes and alterations in the conſtitution or texture of ſoils, ſuch as rendering them more open and porous, or more ſtiff and compact, and by ſuch means bringing them into the moſt proper conditions for the bearing of different vegetable productions; and there are ſtill others that contribute in all or ſeveral of theſe ways at the ſame time.

From the great differences that are thus met with in the principles, or in the agency, of the matters that are made uſe of as manures, it becomes difficult to adopt that ſort of arrangement which may be of utility in practice. That which ſerves to diſtinguiſh, in ſome meaſure, the nature of the materials from which they are derived, would ſeem to be of the moſt advantage in the cultivation and improvement of land; hence they may be divided into ANIMAL, VEGETABLE, FOSSIL, SALINE, and COMPOUND MANURES.

MANURES FROM THE *DECOMPOSITION* OF *ANIMAL SUBSTANCES.*

SUBSTANCES of the animal kind, when reduced by the proceſs of putrefaction, or other means, into a ſoft, pulpy, or mucilaginous ſtate, are found, by the experience of the moſt correct and able agricultors, to afford thoſe matters which are ſuited to the nutrition and ſupport of plants with greater readineſs, and in more abundance, than moſt other bodies that can be employed. By chemical analyſis it has been ſhewn that the component materials of theſe ſubſtances, ſo far as agriculture is concerned, are principally water, jelly or mucilage, and ſaccharine oleaginous matters, with ſmall portions of ſaline and calcareous earthy ſubſtances. Hence animal matters, though they agree, in ſome circumſtances, with vegetable productions, each having, in common, water, ſaccharine and calcareous matters, are far more compounded; and in animal ſubſtances, ſome of theſe materials are in large proportion, while in vegetables they only exiſt in a very ſmall degree; and the jelly, which, in ſome meaſure, reſembles the gum and mucilage of plants, differs likewiſe from them, in its having much leſs tendency to become dry, as well as in its property of attracting humidity from the atmoſphere, and of running with great rapidity into the ſtate of putrefaction and decay.

All theſe principles of animal ſubſtances are reſolved by their ultimate decompoſition into other matters, ſuch as the different gaſſeous fluids that have been mentioned above, carbon, phoſphorus, lime, &c.

It would feem probable, too, that in animal fubftances of different forts there may be differences in regard to the proportions of thefe feveral ingredients or principles. Some kinds affording one or more of them, in greater abundance than others; while others again are deficient in thefe, but abound in fome of the others. On this fuppofition, the different effects of fubftances of the fame clafs, when applied to foils of the fame kind, may be eafily accounted for.

Animal fubftances of every kind, on being deprived of their vital principle, have a quick tendency to take on or run into the ftate of putrefaction, a procefs which is confiderably affected and influenced by the circumftances under which it is produced. But in the horny and more compact animal matters this tendency to putrefaction and decompofition is, under fimilar circumftances, much lefs rapid, than in fuch as are of a lefs firm and denfe texture. The procefs of putrefaction is, however, greatly expedited by the conditions under which it takes place being favourable; fuch as the fubftance, of whatever kind it may be, poffeffing fufficient moifture, being expofed to the free action of atmofpheric air, and a moderate degree of heat. On various accounts it would likewife appear, that the decompofition of fuch fubftances may be promoted by moiftening them with water flightly impregnated with common falt, and, perhaps, fome other faline fubftances, fuch as the muriats of magnefia and foda, or fea-falt, as ingenioufly fuggefted by the Earl of Dundonald *.

It is probable alfo that the decompofition of fome of the more hard and folid animal fubftances that are employed as manures, fuch as horns, bones, hoofs, and rotten rags, &c. might be greatly promoted, and rendered more immediately ufeful, by being reduced into much fmaller particles than has been ufually done, and by the application of higher degrees of heat than that of the atmofphere.

As the diffolution of animal as well as vegetable matters is known to be much impeded by their being excluded from the air, or expofed to fuch degrees of heat as are capable of drying up and taking away their moifture, and by the mixing of fuch earthy fubftances with them as are capable, from their open and porous textures, or vitriolic and other qualities, of depriving them of the fluid matters which they contain, we may fee why, under certain circumftances of their being mixed and applied as manures, they may prove lefs beneficial than in other inftances.

There are fome other circumftances, befides thofe that have been mentioned, that render the decompofition of all fuch fubftances more quick and expeditious,

* See Connection of Agriculture with Chemiftry, pp. 74 and 87.

fuch as their being lightly depofited together, and not in too large heaps, or with too much earth mixed and depofited upon them, by which the air is prevented from acting upon them fo extenfively as it might otherwife do. By fprinkling common water over them frequently, efpecially in hot and dry feafons, and where they are of the more hard and compact kinds, their diffolution, in many inftances, might probably be rendered more quick and complete; and confequently the food or nourifhment of plants be more readily and more abundantly fupplied.

Hard Animal Subftances.—In the matters of this fort that are employed as manures, there is confiderable differences in refpect to their texture and firmnefs, fome being quite firm and folid, fuch as bones, horns, hoofs, fhavings of horn, and fome other fimilar fubftances, while others are more foft and pliable. The bones of all animals are capable of affording much nutritious matter to plants, but thofe which are procured from cattle that have been killed when fat, are faid to be the beft for the purpofes of manure. Thofe which have been boiled are far inferior, in this view, to thofe which have not undergone that procefs, as by fuch means they are principally robbed of their oily and mucilaginous properties, and confequently muft yield much lefs nourifhment to the immediate crop, whether it be grain or grafs. All thefe forts of fubftances require to be ground down in mills conftructed for the purpofe, or otherwife reduced into fmall pieces, before they are laid on and mixed with the foil, or formed into compofts. The ufual method is to reduce them to about the fize of large filberts, but there can be little doubt but that they would fooner run into the ftate of putrefaction if they were reduced into ftill fmaller particles, and thus be made to afford their nutritive properties much more expeditioufly, as well as more abundantly; by which means much lefs quantities would probably produce equally full effects with the large ones at prefent made ufe of, as where the pieces into which they are broken are left large, they remain a great length of time in the foil, and are only gradually decompofed, without yielding that full fupply of nourifhment which is neceffary for the fupporting of crops. And when they have been even prepared in this way, too much earthy materials fhould not be mixed with or applied upon them, as where this is done, by preventing the free operation of the air, their decompofition is greatly retarded. Nor fhould they, upon the fame principles, when intended to be incorporated with the foil, be ploughed in too deeply, as by fuch a practice the crop will be deprived of much of the advantages which it might otherwife have obtained from fuch manure.

Thefe fubftances are conftituted of a confiderable proportion of mucilaginous

or gelatinous matter, a ſlight portion of fat, and an earthy ſalt compoſed of the phoſphoric acid and calcareous earth. If great heat be applied, they afford a large quantity of hydrogen gas, carbonic acid gas, and a volatile alkaline liquor. From the nature of theſe different principles, it is evident that ſome ſorts of ſubſtances may be blended and united with the reduced particles of bony matters, ſo as to promote their effects, as manures, in a conſiderable degree, ſuch as lime, chalk, peat earth, and good vegetable mould, in ſuitable proportions, as by ſuch means new combinations may be formed highly favourable to the proceſs of vegetation.

The conſuming of bony or horny ſubſtances, by means of fire, for the purpoſe of obtaining their aſhes, is a waſteful diſſipating practice that ought never to be attempted by farmers, as by it the mucilaginous and oily materials are driven off and loſt, and nothing remains but a phoſphat of lime, which can be of but little uſe in promoting the growth of vegetable crops.

Soft Animal Subſtances.—There are various matters of this nature that may be of uſe for the purpoſe of improving land as manures, ſome of which have yet been but little attended to by the farmer. Of this ſort are *greaves,* or the reſiduum which is left after the making of candles, and the *ſcum* which is collected in the boiling or refining of ſugar.

Different trials, upon a ſmall ſcale, with the former, have fully convinced us that it is a ſubſtance that poſſeſſes great powers, when employed as a manure. And although it is a ſubſtance which is generally procured at a high price; from its going a great way, and being a laſting manure, it may, probably, be more frequently had recourſe to than has hitherto been the caſe. It is moſtly procured in the ſtate of hard compreſſed ſquare cakes, though ſometimes in a ſoft condition, without having undergone any preſſure. When in the former ſtate, the cakes muſt be broken down and reduced into as great a ſtate of diviſion as poſſible, which may be rather a troubleſome and expenſive proceſs, except a mill, or ſome proper machine for the purpoſe, be employed. But when it has been even reduced to the fineſt ſtate poſſible, it will ſtill be improper for application as a manure, until it has been mixed and incorporated with a pretty large proportion of ſome rich earthy ſubſtance with which it may combine. In the attempts which we have had an opportunity of making with this animal ſubſtance, after being much reduced, it has always been blended in the proportion of three or four parts of good vegetable mould, according to the condition of the land, to one of the greaves, and then ſown

as a top dreffing on grafs land, where it has never failed to produce a full crop of hay, confiderably greater than that by the ufual dreffings of dung, and a rich fweet after-grafs, or fuch as cattle were remarkably fond of feeding upon.

In a very obliging communication on this fubject, from an able and intelligent practical agricultor, Dr. Wilkinfon, of Enfield, it is conceived that the animal kingdom furnifhes the ftrongeft manures, among which he has found greaves to be the moft powerful and durable in their effects. From one ton to a ton and a half, he confiders as fufficient for an acre, according to the ftate of the land. The cakes in his practice are, he fays, minutely divided, which on account of their hardnefs is an expenfive and laborious operation; and that even in this ftate of minute divifion, unlefs mixed with mould, they frequently prove too ftrong for corn, as he found by experience, on applying them to barley, the grain of which was injured by the ranknefs of the ftraw. They are, he conceives, peculiarly adapted to promote the growth of grafs, turnips, and the leguminous plants.

Eight acres of pebbly loam were, he remarks, manured with dung, at the rate of ten loads of the common Middlefex carts per acre, except one acre of the pooreft and moft gravelly, which was dreffed with a ton and a half of greaves. The turnips where the greaves were fpread, and the fucceeding barley (which were the crops on the whole piece), were thicker and more vigorous than where common dung had been laid. He has obferved grafs rendered fo rank by the ufe of greaves as a manure, that cattle would not touch it till mellowed by the winter's froft; and even in the fucceeding year he was able to trace, by the fuperior verdure of the grafs, to what extent this manure had been fpread. He has alfo ufed with fuccefs, he fays, falted fifh provifions, and particularly herrings, which had been fpoiled on fhip-board, and has found them equal to the greaves. In the fame manner he has ufed falted meat that had become putrid on a long voyage. His general mode of application has, he fays, been to mix them with mould raifed from the headlands of the field where they were intended to be fpread. By letting them lie for fome time, the earth imbibes the ftrong fmell and virtues of the animal manure. Over thefe he has fpread, with advantage, the liquor drawn from the greaves, and the wafhings of the cafks of falt meat which had been fpoiled. When fprinkled immediately over grafs in the fpring, he has alfo obferved this liquor attended with confiderable efficacy in producing a plentiful crop of hay.

Laft year, 1800, he fays, he ufed with fuccefs a combination of lime

and greaves, mixed with mould from the headlands, in the proportion of about fifty buſhels of lime to a ton of greaves. This compoſition, he obſerves, reſembles *ſugar ſcum*, which conſiſts of lime and bullocks' blood.

From the large experience he has had of the benefits ariſing from ſugar ſcum, he thinks this combination of lime and animal matter deſerves further inveſtigation.

There can be little doubt but that by combining lime with animal ſubſtances, they may be rendered highly active as manures, eſpecially when applied on ſoils that have a ſufficiency of thoſe earthy ſubſtances on which they can exert their full influence.

In this way they ſeem frequently to be rendered more active than when employed in a ſimple uncombined ſtate; but experiments are perhaps wanting to fully aſcertain the utility and beſt means of employing ſuch matters.

Lime might thus be combined with bones or woollen rags, or with a compoſt of earth and night-ſoil; and would certainly greatly facilitate their converſion into manure, as well as render them more active in producing their effects in the ſupport of vegetable crops. And by ſome of their properties being abſorbed by the lime, during the time of their decompoſition, and afterwards parted with more ſlowly in the ſoil, they may alſo by ſuch means be, probably, rendered more durable and laſting, as manures.

It is further obſerved, by this experienced agriculturiſt, that the Arabians, who take great pains to improve their lands, are accuſtomed to make large pits; they then put in animal ſubſtances, and cover them with calcareous or clayey earths, and afterwards theſe earths, which of themſelves are ſterile, acquire the properties of the richeſt manure. He ſays, he once ordered a heifer which died in a field at a diſtance from his houſe, to be buried in a compoſt of lime and earth; he does not aſſert that this was its moſt profitable application; he had, however, no reaſon, he ſays, to complain of his compoſt.

Mr. Wight, in his Survey of the Huſbandry of Scotland, he obſerves, mentions a compoſt of two parts lime, and one part pigeons' dung, to remain mixed until a conſiderable fermentation advances, which is known by the effluvia. Six bolls of this compoſt, he ſays, is ſufficient for an acre, and will mark itſelf for many years.

There are many combinations of this nature that may be ſucceſsfully made uſe of for the purpoſes of agriculture, but which have not yet been ſufficiently attended to, to aſcertain their different effects.

There are ftill more fubftances of the animal clafs, fuch as the *refufe of glue-makers*, the *cuttings of felt-mongers*, the *clippings of furriers*, the *fcrapings of oiled-leather*, and the *chips or wafte of fhoe-makers*, which may be made ufe of as manures, when they can be collected in fufficient quantities. Thefe animal materials, from their abounding in mucilage and oil, their great attraction for moifture, and their being readily foluble in water, contribute quickly to the fupport of vegetation, but are not probably fo durable in their effects upon land, as many other fubftances. Hence they fhould only be made ufe of with a view to the immediate crop, which, we believe, is pretty much the cafe in thofe places where they can be obtained in fuch quantities as to be employed for the purpofes of agriculture.

Various animal fubftances of the fifh kind, as the blubber remaining after the preparation of oil from the whale, and other large fifhes, and different forts of fmall fifh, both of the fhell and other kinds, may be employed as manures; and alfo the offals of fuch animals, where they can be procured in a large quantity, as in large towns, fea diftricts, and where they are cured or prepared in great numbers for the market.

Thefe fubftances may be readily reduced to that ftate which is proper for manure, by mixing with them a fmall portion of the carbonat of lime, and afterwards, according to circumftances, a quantity, two or three times more than the whole, of good vegetable mould. Shell-fifh, fuch as mufcles, are commonly applied without being mixed with earthy matters; but this is certainly a wafteful practice, as much of their valuable principles is diffipated and loft, as is evident from the highly difagreeable ftench that affails the neighbourhood of the ground on which they have been applied. By mixing good vegetable mould or peat earth with them, as has been mentioned above, the quantity of the manure would not only be greatly increafed, but the offenfivenefs attending the ufe of fuch manures, in a great meafure, corrected, and the effects of them in promoting the growth of vegetables probably rendered more advantageous.

The refufe of flaughter-houfes and butchers' fhops may, likewife, be prepared and made ufe of in a fimilar manner to that of fifh. For as the manures that are formed from thefe animal materials are capable of affording much elaftic volatile matters during their decompofition, they of courfe require to be well mixed and blended with fuch earthy fubftances as they can combine with, and render foluble, and in proportions fuited to their powers, in order to produce the moft beneficial effects on vegetation.

It is probable that woollen-rags, hair, feathers, and fuch-like fubftances, from their having a lefs portion of oily or mucilaginous matter in their compofition, are inferior as manures. The firft muft be cut or chopped into fmall pieces before it can be advantageoufly applied to the ground.

From the experiments that have been made with fuch animal fubftances as have been mentioned as manures, it may be inferred that their effects continue longer than thofe of many fubftances of other kinds. Dr. Hunter found from the application of reduced bones to a poor calcareous foil, with a grain crop, in the proportion of fixty bufhels to the acre, that the crop was much fuperior, when this was ufed, to that which had not been dreffed in the fame way, and the grafs crops afterwards for fome length of time, on the fame place, difplayed a fuperiority, and appeared more early. He alfo found the fame fuperiority in turnip crops in different fields, when dreffed in the fame way. Mr. Young likewife found the effects of bone manures to be very great; but they did not correfpond to the quantities employed, as with twenty-five cart loads the crop was better than with fifty*. This curious fact is, however, explained, by his obferving that the foil was an extremely poor one, as in fuch a cafe there could only be a fmall proportion of earthy matter for the ammonia and other fubftances afforded by the decompofition of the bones to act upon, and reduce to that ftate of folubility the moft adapted to the fupport of vegetation. Hence the immediate benefit that was derived from the manure, probably, depended folely on the oily and mucilaginous materials.

Where bony fubftances are not broken down into very fmall particles, we fufpect, from fome few trials that we have been enabled to make, that the effects of fuch fubftances will be equally, if not more, apparent the fecond than the firft year, whether they be ufed on grafs land, or that which is under the plough. The trials which Dr. Hunter made with ground and unground bones feem, likewife, to fupport this opinion, as he found that, for the immediate crop, the unground bones were of little or no fervice, but the ground ones of much benefit. What effect the unground ones had the fecond year is not exactly mentioned; however, from his concluding that thefe fubftances are, in general, upon grafs land, more effectual the fecond than the firft year, it may be eafily fuppofed to have been the cafe.

Animal dungs.—The animalized fubftances that are, however, moft generally

* Annals of Agriculture, vol. III. p. 69.

made ufe of as manures, are the excrements of various kinds of animals, which are found in very different conditions, or ftates of preparation and richnefs, proceeding, in fome meafure, from the kind of food on which the animal has been fed, the matters with which they are incorporated, and the texture of the fubftances themfelves.

It is ftated by a very correct practical obferver, that the dung of fat animals is unqueftionably more rich, and confequently poffeffes greater powers of fertilization, than the dung of lean ones; and that the quality of the dung of every fort of animal will, in a great meafure, be proportioned to the goodnefs or poverty of its food. Thus, when the animal is fed on oily feeds, fuch as lint, rape, and others of a fimilar nature, it will be the moft rich; when kept on oil-cake, or thofe feeds which have been deprived of part of their oily matter, the next fo; on turnips, carrots, and fuch-like vegetable roots, the next; on the beft hay, next; on ordinary hay, next; and on ftraw, perhaps, the pooreft of all. The dung of lean hard-working cattle, feeding on ftraw, muft, he conceives, be poor indeed*.

Some manures of this kind, fuch as the foil of privies, is fometimes met with in a ftate fit to be applied to the ground, when not much mixed with fluid matters, fuch as urine. It moft frequently happens, however, that it is in fuch a liquid ftate as to require other more folid fubftances to be blended with it, before it can be conveniently applied to the foil. In doing this, too little regard feems to have in common been paid to the choice of the moft proper materials: but it is obvious, that fuch as can be the moft fully acted upon, and the moft readily converted into the ftates fuitable for affording the nutrition of vegetables, by the principles of the matters thus employed as manures, muft be the moft adapted for the purpofe, as well as the moft beneficial. When, therefore, the manure made ufe of in this way is either wholly or principally conftituted of fuch animalized matters as, from their fluidity, are in an improper ftate or condition to be fet on land without having other fubftances previoufly mixed with them, fuch peaty, boggy, or black vegetable earths fhould be chofen as contain large proportions of matter, which the ammonia or volatile alkali fo abundantly provided by the decompofition of fuch fubftances may exert itfelf upon, and reduce into that ftate of folubility which is fuitable for promoting the growth of plants. By duly attending to this practice, which has been fo fcientifically handled by the Earl of Dundonald†, much

* See Middleton's View of the Agriculture of Middlefex, p. 30.

† See Treatife on the Connection of Agriculture with Chemiftry.

advantage may be gained, not only in the quantity, but likewife in the quality of the manure.

The refults of experiments attentively made in this way, indeed, clearly demonftrate that an inconceivable lofs is incurred by the inconfiderate practice of exficcating human excrement, as well as the negligent cuftom of permitting the liquor or fluid parts of dung heaps to run away. The trials which we have been enabled to make alfo lead us to fufpect, that it is a much more wafteful practice to apply thefe liquors to ground in their uncombined ftate, than in conjunction with fuch earthy materials as have been mentioned above. Befides, much of them muft be imperceptibly carried off by the procefs of evaporation, even when they are carried out in the moft favourable feafons of the year; and they cannot in this way always be made ufe of on thofe foils that contain a fufficient quantity of thofe earthy materials, or principles, with which they can readily form combinations, and exert their moft beneficial and fulleft effects.

Moft of the later practical writers on agriculture are decidedly of opinion, that the *foil of privies* is a manure of the moft enriching kind, but that its effects are not fo lafting as thofe of many other fubftances. In the trials which have been lately made with it, by a very ingenious and experienced agriculturift*, it is faid to have produced fuch aftonifhing fertility as to induce him to conclude that it exceeds all other forts of manure that can be put in competition with it for the *firft year* after its application. The fecond year he thinks it of *fome* fervice, but in the third its effects nearly, if not quite, difappear. The circumftances which render this fort of manure fo immediately active in promoting vegetation, and fo quickly deprived of its beneficial influence, would feem to be from the great quantity of elaftic principles which it contains, in a loofe ftate of combination, and the fmall quantity of earthy matter which it is capable of fupplying to the foil, by the laft ftages of decompofition or decay. This alfo further fhews the advantage of mixing and incorporating with it fuch kinds of earthy fubftances as it may be capable of acting upon, and uniting with. From the caufes juft noticed, its moft active and nutritious properties are almoft immediately fet at liberty, and either directly contribute to the growth of plants, or form fuch new combinations as readily become ufeful for the purpofe, while but very little of the earthy material is left behind for further decompofition, and the durable aid of vegetable increafe. The author mentioned above alfo further remarks, that this matter is not only prepared in the moft fuitable manner for the purpofe of

* Middleton in Tranfactions for the Encouragement of Arts, &c. vol. XVII. p. 236.

perfect vegetation, but that the herbage produced by it is capable of fattening the *largeft* cattle in *lefs* time than any other. And we know from repeated experiment, that the fineft garden vegetables may be produced by it, when properly employed, without the leaft injury to their tafte, even in the moft delicate of them, fuch as cauliflowers, white brocoli, &c. Inftead of a bad tafte being communicated to herbage by the ufe of this manure, it would feem, probably, that it confiderably improves its flavour, as it has been obferved that the patches of fuch paftures as had been manured with this fubftance were conftantly eaten *quite clofe* by horfes, cows, and young cattle, while in other places there was much *longer grafs**.

From thefe facts, the importance of this fubftance, as a manure, is evidently fuch, that every poffible means fhould be contrived to prevent its lofs, which is fhamefully permitted, at prefent, to take place in many large towns, to the aftonifhing extent of more than two thirds of the whole, and fome method made ufe of to render its conveyance and application more general and convenient, which cannot be a matter of much difficulty, if once the attention of practical agriculturifts be properly excited upon the fubject, as we fhall have occafion further to remark when we come to confider the means of augmenting and preferving manures.

The dungs of thofe animals which feed on fuch forts of food as conftitute either wholly, or in a great part, the food of man, as has been noticed above, are found, from the experience of practical farmers, to be more effectual in promoting vegetation, when applied as manures to ground, than thofe of fuch animals as are fuftained by fuch kinds of matters as are feldom or ever made ufe of in that way; hence it is obvious that the dungs of carnivorous birds, dogs, fwine, horfes highly fed, poultry, pigeons, and fuch-like animals, muft be more powerful in their effects as manures, than thofe of horfes when fed only with hay or grafs, neat cattle, fheep, and other animals that live in the fame manner. On the fame principle too, it feems not improbable, but that the excrements of infects may be lefs efficacious as manures than their bodies, as it is well known that by their deftruction and decompofition the fertility of land is confiderably increafed in particular inftances.

It is probable, likewife, that the dungs of fome animals may, from the ftate of their ftomachs and other caufes, as well as the nature of their food, be more completely reduced and animalized in its paffage through their bodies

* See Annals of Agriculture, vol. I. p. 655.

that this is the cafe, at leaft, in granivorous birds, in which the food is fubjected to confiderable trituration in the courfe of its digeftion, there can be little doubt, and thereby they perhaps become, in fome meafure, in a condition more fuitable to form new combinations, or afford the fupport of vegetation.

This view of the nature of the manures afforded by different animals, fhould lead the practical agriculturift to be more attentive to the fubject, in order that he may render them more abundant, and be capable of employing them under the moft favourable circumftances, which cannot be the cafe while they are, as at prefent, indifcriminately mixed and blended in the common dung-heap. That they fhould not be ufed in this way is clear from the contradictory accounts of them that have been prefented to us by various writers and experimenters, which would feem to have been caufed by employing them in ftates of mixture with other fubftances. By fome it is afferted that one load of *fwines' dung* is nearly equal to two of moft other forts, and that it is the richeft of all animal manures; in this, however, they would feem to be miftaken, as from trials made by others, it has been fhewn that *night-foil* is certainly to be ranked much before it. In fome of the ingenious experimental attempts of Mr. Young, it is alfo fhewn that the dungs of rabbits and poultry are fuperior to that of pigeons, and greatly more durable*. But poultry dung, in the comparative experiments of Mr. Arbuthnot, was found to be more effectual than that of rabbits, and that of the latter greatly fuperior to wood afhes. *Pigeons' dung* has, notwithftanding, been proved by much experience to be a powerful and efficacious manure, and probably, from its abounding with volatile alkaline principles, been concluded to be of a hot or ftimulating quality.

It is, however, from the larger animals that the farmer derives the principal part of the dung that is made ufe of as manure, in the cultivation and improvement of land. The dung of fuch horfes as are highly fed being found, as has been already feen, to be much more valuable for the general purpofes of agriculture, and fome ufes in horticulture, than that which is made by horfes when fed with hay or grafs only. Where the animals are kept in the latter way, it is, probably, not fo good as that of well-fed cows and neat cattle in general, as in thefe it may, perhaps, become more animalized from the circumftance of their food being more intimately blended with the *faliva*, or other juices, during the ruminant ftate of feeding in fuch animals. The dung of

* See Annals of Agriculture, vol. II. p. 26.

horfes is, however, in common, much more difpofed to take on the procefs of putrefaction, and caufe more heat, than that of cows and other neat cattle, and indeed thefe are the chief diftinguifhing circumftances between them as manures. The dung of neat cattle may alfo, on account of its lefs difpofition to run into the ftate of putrefaction, contribute more of the earthy material to the land on which it is applied. Hence, probably, its fuperior utility on the leaner and poorer or thinner forts of foil. The dung and urine of animals when newly voided are not, except when the animals are morbid, in a putrefcent condition, the length of time in which they remain in their bodies being too fhort for its fully taking place; but fome degree of, or tendency to, putridity is conftantly neceffary to their difcharge*, and the means which are further fuited to promote it in thefe fubftances, have been fully defcribed and explained above, in fpeaking of the nature of animal fubftances in general.

From the few experiments that have been made with the dung of fheep, it is evident that it is equally valuable with that of many other animals that feed in the fame way, but agriculturifts have not yet turned their attention fufficiently to the means of collecting and preferving it, fo that it may be ufed alone as a manure. The method by which it is at prefent applied to land is by folding the animals upon it, under which method of management, on many foils, a great part of the advantage muft be derived from the operation or action of the ammonia of their urine upon the vegetable matters contained in them, as well as from the confolidation produced by their treading.

MANURES FROM THE *DECOMPOSITION* OF *VEGETABLE SUBSTANCES.*

VEGETABLE, as well as animal, fubftances, when deprived of their vital principle or life, are foon rendered fit, by the feparation, reduction, and ultimate decompofition, of their conftituent principles, for the nourifhment and fupport of new plants. In this procefs, which we have already feen to be greatly promoted in all kinds of fubftances by the materials being expofed to the free influence or agency of atmofpheric air, moifture, and a middling degree of heat, various matters are fet at liberty, by which different new combinations take place, that are capable of promoting vegetation in different degrees, and upon which their utility as manures, perhaps, chiefly depends. The ftages of this

* See Dundonald on the Connection of Agriculture with Chemiftry, p. 100.

decompofition have generally been fuppofed to regularly fucceed one another, from that which is productive of fweetnefs, through the vinous and acetous, to that which is the ultimate refult of putrefaction. But a late philofophical writer* ingenioufly fuggefts, that it is more probable that different forts and parts of organifed matters, when dead, may undergo many different forts of chemical changes, and that thefe may be different according to the differences in the degrees of heat, the quantity of water, and of air, to which they are expofed. He appears to have been led to this fuppofition from the faccharine procefs, preceding the vinous fermentation, which takes place in certain ftates of animal ftomachs; and from what happens in the germination, or fprouting, of grain, by which the mealy matter is converted into fugar. From remarking that the acerb juices of fome kinds of fruit are rendered fweet by baking, he conceives, that the faccharine procefs may take place in a degree of heat which is about that of boiling water, and that by it the procefs of fermentation may be altogether prevented from occurring. By deftroying or injuring the life of fruits, it is alfo fuppofed, that the faccharine procefs of their juices may be promoted, as is found in many inftances; fuch as the ripening of fruits after being plucked from the trees; their being fooner ripened after being injured by infects, or other means; and after partially cutting, or otherwife injuring, the branches of the trees on which they grow: and this, which is termed the faccharine procefs, it is conjectured, may take place either beneath or upon the earth, in the incipient ftate of vegetable decompofition, before the vinous fermentation, and thus afford a very nourifhing matter to plants.

In the vinous, or procefs which commences after the faccharine, carbon becomes united with pure air in a large proportion; and it is fuppofed, by the author we have juft mentioned, that probably at the moment of their combination, while they are in the form of a liquid, and before they affume the gaffeous ftate, they may be taken up by the roots of vegetables.

And, as in the procefs of putrefaction, carbon is not only changed into carbonic acid, but water decompofed, as is evinced by the fmell of hydrogen, it is fufpected that that inflammable fubftance may combine with carbon, as in the cafe of hydrocarbonate gas, and by this means render them both foluble in water, and thereby capable of being taken up as food by the roots of plants, without their paffing into the acid or gaffeous ftates. The union of azote with

* See Darwin's Phytologia, p. 229.

pure air, towards the clofe of the putrefactive procefs, by which nitrous acid is produced, it is likewife conceived may poffibly tend to promote vegetation. This, however, may be promoted, from the circumftance of the pure air, or oxygen, adhering more loofely to its bafe, the azote, in the formation of this than other acids, and on that account yielding it more readily to the abforbent roots of vegetables. But, befides thefe means of fupplying the nutrition of plants, as in the decompofition of vegetable fubftances by the procefs of putrefaction, the conftituent principles of the water which they contain are, as has been juft obferved, in fome meafure fet at liberty, and the hydrogen, one of them, uniting with the azote which is afforded by the diffolution of vegetable matters, though not in fuch large proportions as by animal fubftances, forms ammonia, which, from its ready union with fats and oily matters, and thus rendering them capable of being taken up by the abforbent roots of vegetables, may contribute to the fupport of vegetation. And, in fome inftances, where faline infoluble earthy matters, or metallic falts, are contained in the foils to which manures of this kind are applied, or in which ammonia may be formed, it may decompofe them, and by that means contribute to the formation of other new and lefs noxious compounds, or fuch as may be more capable of contributing to the growth of vegetables.

There is another fubftance which generally prevails in vegetables, and which is fuppofed, by the writer we have noticed above, to be a fimple material, obtained in great abundance from the recrements not only of putrefying vegetable, but animal fubftances, and calcareous earth, the latter of which he fuppofes to have been of animal origin in the early periods of the world. This matter, it is thought, when met with in the ftate of folution, may be taken up entire by the abforbent roots of vegetables, as well as occafionally formed and elaborated by them.

It feems probable from thefe ftatements, that different matters, fitted to the nutrition and fupport of plants, or crops, are formed and evolved during the different proceffes and ftages of decompofition of vegetable, as well as animal, fubftances.

In vegetable productions the changes are, however, lefs rapid than in thofe of the animal kind, and probably much more varied, according to the various ftates and textures of the particular fubftances; for it is obvious, from numerous facts and circumftances, that the more luxuriant and juicy vegetables are much more readily decompofed than fuch as are dry, and have a ligneous ftruc-

ture. Hence it is, that fresh vegetable matters are much more quickly converted to that state of decay which is suitable for the supplying of vegetable nourishment, than such as straw, hay, wood, and other dry materials of the same nature.

It seems likewise probable, that some vegetable matters may yield some of the substances that are taken up by the absorbent roots of vegetables in much larger proportions than others; as it has been found that different sorts of grain vary considerably in the proportions of mucilaginous, and what is termed vegeto-animal matter, which they contain; and that grain, potatoes, carrots, and many other roots of the same kind, on being consumed in the open air, afford much larger quantities of alkaline salts than hay, straw, or wood: it is undoubtedly from these and similar causes, that some sorts of vegetable matters, when reduced by means of putrefaction, are found to be so much more effectual as manures than others, when applied under the same circumstances, and to soils in every respect similar.

There is also another circumstance which seems necessary to be attended to in substances of this class, which is, that in general, when resolved by the ultimate process of putrefaction, they yield larger proportions of earthy materials to the soils on which they are deposited, than most substances of the animal kind, and consequently add more effectually to the staple of the land. And as this vegetable mould, or earth, from various causes, is constantly becoming more extensively, and more intimately, blended with the other materials of the soils, and, of course, forming new combinations, by which some of those matters which serve for the nutrition of plants are set at liberty, and brought into the state most proper for being absorbed by the roots of vegetables; we see why those manures, which are principally composed of vegetable substances, are more durable in their effects than such as are prepared from many animal materials.

The substances of the vegetable kind that may be advantageously converted into manure, are so extremely numerous that it is impossible to describe the whole of them. All kinds of green vegetable productions may be employed in this way; such as the luxuriant weeds of rivers, lakes, ponds, and ditches; fern; and the refuse of different kinds of garden vegetables. Where green materials of this nature are made use of, they should always be cut down while in their juicy state, just before their flowers begin to appear, in order that they may be in the most suitable condition for becoming quickly putrid, and to prevent the injury that might otherwise be sustained from the vegetation of their seeds. They are afterwards to be collected into heaps of a moderate size, and their putrefaction promoted

by their being thrown together as lightly as poffible, and the occafional fprinkling of them with water, if the feafon be hot and dry: and as lime is found, when applied to vegetables in their green moift ftate, to difengage from them both hydrogen and azote, by the combination of which volatile alkali is produced *, it may be advantageous to blend a portion of lime at firft with the heaps, and afterwards add a fuitable quantity of peat earth, or good vegetable mould, for the alkali thus formed to act upon. By this method, the quantity of manure from fuch fubftances may be greatly augmented, and rendered more valuable. But when dry materials, fuch as hay, ftraw of different kinds, fern, and rufhes, fuch additions cannot be had recourfe to with equal fuccefs, unlefs where much of the dung and urine of animals have been incorporated with them; but their refolution and decay may be greatly promoted by their being kept in a ftate of moifture, without the water being fuffered to ftagnate upon them, and by their not being permitted to be trodden down too much by cattle, or other means, in the farm yards.

Another beneficial means of vegetable manure, which is yet far from being fufficiently practifed, is that of providing full crops of fucculent green vegetables, fuch as clover, buck-wheat, tares, vetches, fpurry, peafe, beans, turnips, and many other fimilar plants, to be turned down by the plough, in order that they may undergo the putrefactive procefs under the ground, and by that means be converted into manure, and fupply the nutrition of plants. In this practice it is probable that great advantages might be obtained, on the principles which we have juft ftated, by the fpreading of a fmall portion of lime and peat, or rich vegetable earth, over fuch crops, and then rolling them down that they may be completely turned in and buried by the plough; an operation which fhould be performed as quickly as poffible afterwards, and where the crops will admit of it, in the fummer or the early part of autumn, while the fun has the power of promoting the decay of fuch vegetable matters. By this means, it feems probable, that the putrefaction of fuch crops would not only be much expedited, but the principles thereby fet at liberty be capable of exerting their influence much more extenfively than where the plants themfelves are only employed, and little additional expence be incurred by the farmer.

Where crops of green plants can be turned down, when the feafon is fufficiently hot to enfure their fpeedily running into the putrid ftate, there cannot be any doubt but that it is a better and more advantageous practice, efpecially

* See Dundonald on the Connection of Agriculture with Chemiftry, p. 42.

where manures of other kinds are fcarce, than that of procuring it by the confuming of fuch crops by the feeding or foiling of cattle.

Sea-weed * is another vegetable production which is capable of being employed as a manure with great advantage, and fhould never be neglected where it is within the reach of the farmer. In fome places it is the practice to fpread it upon the lands as foon as poffible after being cut from the verges of the rocks on the different fea coafts, or collected after being left by the tides, and to plough it in: where this method is adopted, as little time as poffible fhould be fuffered to elapfe after the cutting, or collecting, of the weed, before it is ploughed down; for as the plant in its green or fucculent ftate readily decays and becomes putrid, if there be any confiderable delay in the performance of the bufinefs, efpecially when the weather is hot, much of its valuable properties as a manure is diffipated, and carried away by means of evaporation, as is fufficiently evinced by the pungent and difagreeable fmell that iffues from it, on its being thrown upon the land while undergoing the procefs of putrefaction: and, befides, when it is fuffered to become dry and hard before it is turned into the ground, the parts of it that remain are confiderably longer before they become decompofed and reduced into the ftate fuitable for affording the nourifhment and fupport of vegetable crops. It is moft probably on thefe accounts, as well as that of the weed affording but little earthy matter in proportion to its bulk, on its decompofition, that it is found, in general, to be lefs permanent in its effects, as a manure, than fome other vegetable matters. Something may likewife depend on the goodnefs and luxuriance of the weed itfelf, and the ftate which it is in when gathered from the fhores, or cut from the fides of the rocks. This, like moft other plants, will undoubtedly be in the moft proper condition for the purpofes of being converted into manure, when cut or collected in the moft fucculent ftate of its growth †.

Another practice, which prevails in fome diftricts where this weed is employed for the purpofe of manure, is that of collecting it into large heaps, and letting it remain expofed in that ftate to the influence of the weather until it be completely rotten, and in a condition to be put upon the land; but as the plant contains in its compofition a large proportion of faline matters, which during the ftate of its decompofition, or decay, are brought into activity, it is obvious that by fuch a method of proceeding much lofs muft be fuftained, not only from

* *Quircus Marina.*

† See Sir John Sinclair's View of the State of Agriculture in the Northern Counties of Scotland, p. 21.

the diffipation of the volatile and more fluid parts by the action of the fun and wind, but by the rains diffolving and carrying away the faline materials that may have been formed. When this weed is, therefore, not to be immediately applied as a manure, it would feem to be the moft economical and advantageous plan, efpecially where the weed is frefh, to firft blend a portion of quick lime with the heaps, and then have a fufficient quantity of frefh good earth, mould, or other fimilar matters, placed beneath them, as well as mixed with and covered over them, in order that the fubftances afforded by the diffolution of the weed may not only have fomething to mix with and act upon, but likewife be prevented from being wafhed away by rains. By this means the quantity of manure may be very much increafed, and its effects rendered confiderably more permanent.

In the iflands of Jerfey and Guernfey, where this weed is extenfively employed as a manure, it is cut in the early part of the fpring, and about the month of July; the firft cutting is, in moft cafes, immediately made ufe of, as a manure for barley and pafture lands, but the latter, principally converted to the purpofe of fuel, the afhes only being employed as manure. By this practice of confuming the plant in its dry ftate, however neceffary it may be in thefe iflands, from the great fcarcity of fuel, the lofs in refpect to manure is extremely great, as the quantity of afhes that are thus produced, bear but a very fmall proportion to that of the weed which is confumed. The weed which is collected after having been thrown upon the fhore by the tides, is found to be much inferior as a manure to that which is cut from the rocks and made ufe of in its juicy ftate, which fully confirms the opinion which has been advanced above.

Bark, which has been made ufe of for the purpofe of tanning leather, may likewife be employed as a manure: when ufed in this way it fhould be collected into moderate fized heaps, before it has become dry by too much expofure to the heat of the fun and wind; and then by having a quantity of lime mingled with it, and being kept flightly moiftened with water, its putrefaction and decay may be greatly promoted. When intended to be applied to grafs lands, it fhould be confiderably more reduced towards the ftate of vegetable mould than when made ufe of for the purpofe of fupporting arable crops.

As during the decompofition of this fubftance much heat is produced, and many elaftic matters fet at liberty, it would feem that as a manure it is more adapted to the ftiff, cold, and heavy foils, than thofe of the lighter kinds; a fact which has, we believe, been confirmed by the experience of moft agriculturifts.

The mud taken from the bottom of rivers, ponds, and other places, where water has ftagnated for fome length of time, frefh or maiden earth, and the fcourings of old ditches, are fubftances that may frequently be employed with advantage as manures, being principally compofed of the recrements of decayed vegetable matters. They fhould not, however, be put upon grounds, efpecially thofe under grafs, until they have been reduced into a confiderable degree of finenefs, by means of frequent turning over, and the mixing of a portion of lime, rotten dung, or other materials of the fame kind, with them, in order to promote and render the decay of the more folid parts more full and complete. In ufing manures prepared from fubftances of this fort as top dreffings for grafs land, they fhould not be fpread on too thickly, or in too large proportions at one application, as where that is the cafe great injury is often done to the fucceeding crop, the grafs not being able to fpread itfelf completely over the furface.

The duft which is fcreened from malt, mixed with the tails, ufually denominated *coombs*, where they can be procured in large quantity, as in the malting diftricts, may be converted to the purpofe of manure. It is obferved, in a paper by Mr. Farey, in the Annals of Agriculture, that the black malt duft, fuch as falls through the kiln-plate in the operation of drying, is greatly preferable to the white, on account of the feeds of charlock, with which it abounds, being deftroyed by the heat: but, befides this, the heat thus applied may, by deftroying the vegetative principle of fuch feeds where they exift, render them and the duft more readily difpofed to take on the procefs of decay and become putrid, and thereby afford the nutrition of vegetables more quickly, as well as more abundantly. This, as well as faw-duft, where they can be had at a cheap rate, may be confiderably improved as manures by incorporating them, in pretty large quantities, with the dung and urine of animals, as by ftrewing them in the bottoms of poultry and pigeon houfes, dung heaps, and neceffaries; and alfo in the bottoms of refervoirs into which the urine of cattle, and the foapfuds after wafhing, are emptied: from the action of thefe matters upon them, they are found to become more quickly in a ftate to be ufed with advantage as manures. Manure of this fort has been found very beneficial when applied in the proportion of four quarters to the acre, fown with the crop for which it is employed *.

The hufks, or cakes, which are left after different oily feeds, fuch as thofe of rape, cole, &c. have been fubjected to preffure in mills in order to obtain their

* See Letters and Papers of the Bath Agricultural Society, vol. III.

oil, may alfo be ufed as manures. Thefe fubftances are generally prepared for application by being reduced into the ftate of a coarfe powder, by mills or other fuitable means, and then fown by the hand, and harrowed in with the feed of the crop for which they are ufed. Some agricultors, however, recommend their being mixed, when thus reduced, thinly, with the materials of fuch dung-hills as are deficient in point of richnefs, as where they have been made by lean ftock with a large proportion of litter. On turning over heaps of this kind, about a ton of oil cake fhould be well and evenly mixed with every twenty or thirty tons of the dunghill compoft: by this practice a rich and good manure is faid to be formed. The fuccefs of thefe fubftances, when made ufe of alone as manures, has been found to depend, in a great meafure, upon the falling of rain foon after they have been put upon the land, as in dry feafons little benefit has been derived from their application. The reafon of this feems to be, that as the cake when ufed is moftly in an extremely hard and dry ftate, it does not undergo that decompofition which is neceffary, until it has been moiftened by the rain, by which it is rendered capable of running quickly into the ftate of putrefaction, and confequently of affording fuch matters as are fuitable for the fupport of plants. When applied without being incorporated with other fubftances, it is moftly laid on to the amount of four or five quarters to the acre, according to the condition of the land.

The refufe or pulp of pears and apples, which have been ground, and the liquor fqueezed from them, may likewife be converted to the purpofe of a manure in the cyder diftricts. When employed in this way, however, fome heavy fubftance, fuch as good earth with a little dung, fhould probably be mixed with it before it is put upon the foil, as by being blended with fuch materials it may be more conveniently and more extenfively applied.

MANURES FROM THE *AGENCY* AND *DECOMPOSITION* OF *FOSSIL SUBSTANCES.*

Substances of the calcareous kind, which are to be confidered under this head, produce effects more or lefs powerful in promoting the growth of vegetable crops, in fome meafure, according to the ftate and quantity in which they are applied, the nature of the foils on which they are employed, and the properties of the matters with which they are combined. For though calcareous materials have been made ufe of as manures for a very great length of time, and been applied in various ways, difficulties ftill remain concerning the manner of their

operation, in many cafes, which feem principally, however, to proceed from the want of proper difcrimination in refpect to the ftate of the different calcareous fubftances at the time of their application, and their being made ufe of to different foils, without a fufficient diftinction of the properties of the materials of which they are conftituted or compofed. There is likewife another circumftance, which the ingenious experimental enquiries of a late author * have fhewn to be neceffary to attend to, which is, the fubftances the calcareous material is combined with; as he has found that where magnefia is in union with the calcareous matter, it is not by any means fo beneficial for the purpofes of manure and promoting vegetation, as where no fuch mixture or combination is prefent, efpecially when ufed in the fame proportions. From fand entering largely into the compofition of lime-ftone or other calcareous matter, in fome cafes, as it is a fubftance of much greater fpecific gravity than pure cauftic lime, confiderable differences in its effects as a manure may likewife be produced †.

On all thefe accounts, therefore, though lime may be produced from chalk, marble, different lime-ftones, coral, and fhells, by fubjecting them to fuch degrees of heat as is neceffary to expel or difengage the carbonic acid or fixed air that they contain, which is apparently of the fame quality, it may vary in its effects when employed in agriculture.

Lime, when newly burned, or before it becomes loaded or faturated with the moifture and carbonic acid, or fixed air, contained in the atmofphere, which, from their ftrong tendencies to combine or unite with it, generally foon takes place, is, in its moft active ftate, and from the power which it poffeffes of breaking down and deftroying the texture and organifation of fuch animal and vegetable fubftances as come in contact with it, is termed *cauftic* or *quick* lime. When applied, under thefe circumftances, to grounds which abound either with frefh vegetable matters, or fuch as have undergone fome degree of change by being buried in the foil, as in moory and heathy mountain land, peaty or boggy earth, and all fuch foils as have long remained in their original uncultivated ftate, covered with a variety of coarfe plants, it is found to produce beneficial effects; in the firft cafe probably by its ready action on the different materials of the green plants, by which it difengages from them hydrogen and azote, from the fubfequent combination of which, ammonia or volatile alkali is produced, a

* Tennant, in Philofophical Tranfactions. † See Anderfon's Effays, vol. I. p. 511.

fubftance which has great power in promoting vegetation, as is evinced in cafes where fubftances that contain this matter in large quantities are ufed as manures; and, in the fecond place, by its combination with the carbonaceous matter of fuch foils, or with that of the various animal and vegetable matters which are contained in them, in fome of the ftages of their putrefaction or decay, and by this means rendering it foluble in water, and thereby capable of being taken up as food by the abforbent roots of vegetables *; and, though lime in its pure or cauftic ftate retards, in fome degree, the procefs of putrefaction, efpecially when ufed in any large quantity, it is probable, that by its power of corroding and diffolving the hard and fibrous parts of vegetable and other matters, as is fhewn by its quickly reducing the ligneous particles of bark, which has been employed in the procefs of tanning, to the ftate of mould, it may bring the abundant vegetable and other materials contained in fuch forts of land quickly into that earthy condition in which they afford the nourifhment and fupport of crops, which by the proceffes of putrefaction, and infect digeftion, could only have been performed in a very flow and gradual manner.

Pure lime too, from its well-known property of deftroying different kinds of infects, fuch as worms, fnails, flugs, grubs, &c. which are moftly abundant in rich frefh foils, may furnifh much nutritious matter for the purpofe of vegetation.

And from its having a greater tendency to combine with mucilaginous oily matters than with fixed alkalies †, a kind of calcareous foap may in fome cafes be formed, that may contribute, in its liquid ftate, to the nourifhment of plants.

When pure lime is mixed with clayey foils which do not poffefs too great a degree of humidity, it is likewife capable of rendering them lefs ftiff and tenacious, confequently more fuitable for admitting the fmall fibrous roots of vegetables, not only by the evolution of heat and other elaftic matters, during the period of its becoming faturated with the moifture and fixed air, or carbonic acid, which they may contain, but alfo by being thereby moft intimately and minutely mixed with them, from the fine impalpable powdery ftate to which it is neceffarily reduced. Where, in fuch foils, the fulphuric acid abounds, it may likewife produce good effects, by forming with it a kind of gypfeous compound, and where other acids are prefent that are prejudicial to vegetation, by the power which it poffeffes of neutralifing them.

* Darwin's Phytologia, p. 203.

† Nicholfon's Philofophical Journal, vol. I. p. 170.

And where the lime has been burnt from the magnefian lime-ftone, it may probably be ferviceable when applied to clayey or other foils that contain the fulphuric acid, which are ufually denominated four lands by farmers, by forming a fort of Epfom falt in the ground, a fubftance which the experiments of Dr. Home have long fince fhewn to be highly favourable to vegetation when ufed in fmall quantities.

Lime, on expofure to the atmofphere for fome time, undergoes a confiderable change, being rendered mild by the abforption of carbonic acid or fixed air from it. In this ftate of combination it is termed, by modern chemifts, *carbonat of lime*, or *effete* lime; its power or capability of acting upon, and deftroying or breaking down, the texture of organifed bodies, being greatly diminifhed. It ftill, however, promotes their diffolution and decay, by aiding and forwarding the natural procefs of putrefaction, as is fufficiently proved by thofe compoft dung-heaps with which it has been mixed becoming much more quickly in the ftate to be applied to land than where no fuch ingredient had been employed; by this means it therefore contributes greatly to the fupport of vegetation: and it has been lately obferved, that where incorporated or blended with fuch compofts of foil and manure, as are in the ftate of generating nitrous acid, it arrefts the acid as it forms, by which means a calcareous nitre is produced, and thus the exhalation and ready efcape of a nutritious material is guarded againft and prevented *.

The combination of lime with carbonic acid, by rendering it foluble in water in its fluid ftate, without being expanded into gas or vapour, may likewife fupply much carbonaceous matter for the fupport of vegetation, as has been ingenioufly conceived by the fame author. The property poffeffed by lime, of fuperfaturating or overloading itfelf with moifture, attracting or drawing it away from the air in contact with the furface of the ground and the earth underneath, and after depriving them of it and the carbonic acid which they contained, permitting them to efcape again, as has long been obferved in the cafe of newplaftered walls, may alfo be of confiderable utility when it is applied to the more dry and fandy forts of foil, by affording moifture and fuch aërial matter to the roots of the vegetable crops; which it is capable of fupplying in a very equal and extenfive manner, from the extreme ftate of pulverifation to which it is frequently reduced when flaked by the dampnefs of the atmofphere, or very gentle rains.

Befides thefe modes of promoting the growth of vegetable crops, it has been

* See Darwin's Phytologia, p. 218.

fuppofed that calcareous earth, by containing phofphorus, may alfo be ufeful, as by its union with it, a kind of hepar may be produced, and the phofphorus thereby rendered foluble in water, without becoming an acid by means of its combination with oxygen or vital air *. Phofphorus he conceives to be probably as neceffary an ingredient in vegetable as in animal bodies, as is evident, he thinks, from the phofphoric light feen on rotten wood, in fome of the ftages of putrefaction; in which, he imagines, the phofphorus is fet at liberty from the calcareous earth, or from the fixed alkali, or the carbon of the decompofing wood, and acquires oxygen from the atmofphere, both warmth and light being omitted during their union. And it may, he further obferves, perhaps more frequently exift in the form of phofphoric acid in vegetables, and be thus readily combined with their calcareous earth, and may be feparated from its acid by the carbon of the vegetable during the time of calcination, and alfo in the procefs of putrefaction.

This view of the nature and properties of lime fhew that it may be employed, in one or other of its forms, more generally to foils than has been fuppofed by agricultural writers. It fhould, however, never be made ufe of without duly attending to the nature and conftitution of the foil on which it is to be applied, as upon this circumftance its fuccefs will, in a great meafure, depend; and it is, perhaps, only by it that the proportion, the ftate, and the manner of its application, can be advantageoufly directed.

It is evident, from the various trials that have been made, by practical farmers, that the more intimately and the more minutely lime is blended and incorporated with the foils on which it is applied, the more full and complete are the effects which it has in fupporting the growth of different forts of crops. Thus it has been remarked by a very intelligent writer, that " if a heap of lime of a confiderable thicknefs fhall have been ever fo long on one fpot, and be afterwards carried clean away from it, fo that none of the particles of the lime remain to be mixed with the foil, that fpot will not be richer, or carry more luxuriant crops, than the places around it; which, every one knows, is not the cafe with regard to dung." And again; that " if lime be fpread upon the furface of the foil, and allowed to remain there without being ploughed in, its effects will fcarcely be perceived for feveral years, till it has had time gradually to fink through the fward, and mix with the foil; after which its effects begin to be perceived, although much lefs fenfibly than if the fame quantity of lime had been intimately mixed with the foil by means of the

* See Darwin's Phytologia, p. 215.

plough and harrow." He obferves, that he is not a ftranger to the improvements that have been made in Derbyfhire by means of lime, without the plough; but this is no exception, he thinks, to what he has faid. The effects are flow, though certain. Thofe who inhabit countries that admit of the plough, are often, he fays, advifed to lay lime upon the grafs, and are made to believe that their pafture will be inftantly mended by it, nearly in the fame perceptible manner as if it had been dunged. This he has tried, and has feen it tried by others; but always found that the grafs for the firft year was rather hurt than benefited by it; nor was it fo much improved in fucceeding years, as if the fame quantity of lime had been applied, and intimately mixed with the foil. In this mode of applying lime, it is long, he thinks, before it yields a proper return; and is not to be recommended to a poor man, unlefs where neceffity obliges him to practife it *.

On thefe grounds it is likewife conceived, that lime may be employed much more advantageoufly when made ufe of, even in fmall proportions, than fuch calcareous fubftances as have been reduced into the ftate of powder without calcination. It is well remarked, however, by the fame author, that much muft depend on the mode in which the lime is applied. " If," fays he, " it is fpread as foon as it is flaked, while yet in a powdery ftate, a very fmall quantity may be made to cover the whole furface of the ground, and to touch an exceedingly great number of particles of earth; but if it is fuffered to lie for fome time after flaking, and to get fo much moifture as to make it run into clods, or cake into large lumps, it can never be again divided into fuch fmall parts; and therefore a much greater quantity is neceffary to produce the fame effect, than if it had been applied in its powdery ftate. But if the foil is afterwards to be continued long in tillage (as thefe clods are annually broken fmaller by the action of the plough and harrows), the lime muft continue to exert its influence anew upon the foil for a great courfe of years; it will produce an effect nearly fimilar to that which would be experienced by annually ftrewing a fmall quantity of powdered lime over the whole furface of the foil: but as the price of the lime muft, in the firft cafe, be paid by the farmer altogether at the beginning, which only comes to be fucceffively demanded in the other cafe, this deferves to be attended to, as it may become a confideration of fome importance where lime is dear, and money not very plentiful."

There is another circumftance that requires to be confidered in refpect to the

* Anderfon's Effays, vol. I. p. 523.

application of lime, which is, the quantity that may be neceffary to be employed. The opinions of practical writers are much at variance in regard to this point, fome contending that a fmall quantity can only be applied with fafety and advantage, while others maintain that fcarcely too great a proportion can be made ufe of. It is obvious, however, from the differences that take place in foils, that no particular proportion can be fuitable in every cafe, but that it muft be varied very confiderably according to the circumftances that have been already ftated, as well as from the fituation or condition of the land on which it is laid, and the proportion of *real* calcareous matter that may be contained in the lime that is to be applied. As it has been fhewn that lime, when in its moft active ftate, foon becomes reduced fo as to be perfectly mild by its property of abforbing moifture, and the carbonic acid from the air, there can be little danger of injury from its cauftic quality, though it may, on its firft application, have a tendency to unite with and deftroy fuch green or other vegetable productions as may be prefent.

It is remarked, however, by a late practical writer, that " moft kinds of *ftone-lime* fhould be applied with a fparing hand, and with a confiderable degree of caution, as the *cauftic* quality is many times greater in *this* than in lime made from chalk." He has had many opportunities, he afferts, of feeing total barrennefs induced by *a too liberal ufe of it*; very generally at the feveral places where the carts were ftopped for the men to fpread it; at the bottoms of every heap; and once an entire clofe *.

It has been employed in different proportions, from one to fix or feven hundred bufhels on the acre, on various forts of foil, by fome very accurate agricultors, under fimilar circumftances, with benefits in proportion to the quantities applied in augmenting the fertility of the foil. And accidental experiments have demonftrated that it may be ufed in ftill larger proportions with advantageous effects †. In fhort, it is concluded by this writer, that, " on foils which do not naturally abound with chalk, or other calcareous matter, there is lefs danger in giving too much lime, than in applying too little, except in thofe cafes where an over-luxuriance is dreaded."

It has been afferted, that lime never contributes to increafe the fertility of foils, but that it has detereorated them greatly by promoting their over-ex-

* Middleton's View of the Agriculture of Middlefex, p. 308.

† See Anderfon's Effays, vol. I. p. 529.

hauſtion *. This ſeems, however, difficult to explain, when the nature of its properties are fully conſidered ; and it is more probable that ſuch an effect may have proceeded from injudicious cropping, and improper cultivation, than the operation of the manure, eſpecially as it has been employed in many well-cultived diſtricts very extenſively, and for a great length of time, without any diſadvantage of ſuch a nature having been experienced †.

The duration of the beneficial conſequences of the uſe of lime in promoting the growth of vegetable crops muſt be different, according to the differences of circumſtances in the land to which it is applied ; the proportion of it that is employed, the kind of crop that is cultivated, and a variety of other cauſes of the ſame nature. But it is evident from the facts that have been ſtated by practical writers, in reſpect to its continued powers of prediſpoſing lands on which it has been laid to the growth of particular ſorts of crops in preference to others; of rendering the operation of other kinds of manure, and other methods of culture, more effectual than where it has never been uſed; that it muſt produce very uſeful permanent changes in the ſoils to which it is applied ‡. An additional proof of this is likewiſe met with in the well-known circumſtance of the quality of the grain from ſuch lands as have been limed being much improved, having a thinner ſkin, and yielding much more flour than from ground where it has never been made uſe of; which is ingeniouſly ſuppoſed, by an able author, to proceed from its containing more ſtarch and leſs mucilage, on account of the tendency of the lime to promote the converſion of the latter ſubſtance into the former, by haſtening the ripening of the ſeed §.

This alſo ſhews the importance of this ſort of manure in thoſe kinds of land that are late in bringing their grain crops to perfection, whether from their particular nature, or the ſituations in which they are placed.

Lime has been ſometimes objected to as a manure for tillage lands by agriculturs, on account of its ſuppoſed tendency to ſink down in the ſoil below the reach of the plough, and thereby becoming of no utility. This can probably, however, only be the caſe where the lime has not been ſufficiently burnt, or afterwards, on its application, properly reduced into the powdery ſtate, and ſpread out equally over the land ; as where theſe points have been well attended to, from its having conſiderably leſs ſpecific gravity than moſt ſoils, no ſuch conſequence can take

* Middleton's View of the Agriculture of Middleſex, p. 309.

† Anderſon's Eſſays, vol. I. p. 532.

‡ Ibid, p. 534.

§ Darwin's Phytologia, p. 220.

place ; the fine particles of the lime, from their being fo very minutely intermixed and blended with the earthy materials, not having any difpofition to fink down through the fuperficial ftratum of mould: but when applied in a coarfer and lefs reduced ftate, from its dry quality, and that of its not intimately combining with the particles of the foil in the way of animal or vegetable manures, it may occafionally fall down, when collected on the furface, during the time of reiterated ploughing, or otherwife ftirring the ground, and reft upon the more ftiff and firm fubfoil below the track of the plough.

On thefe accounts it may, therefore, be neceffary, in the application of lime, to pay greater attention than ufual, not only to the preparation, but likewife the reduction of it into the moft perfect powdery ftate, as well as the fpreading it out over the land with the greateft equality when dry and free from lumpinefs. It may alfo be of advantage where it has been laid on the furface of land, efpecially the grafs kind, to plough the firft time after fuch application with but a light furrow, as by this means the portion that may fall down in the way mentioned above, will not merely be prevented from getting to fuch a depth as may render it ufelefs, but be more intimately incorporated with the foil by fubfequent ploughings*.

It is probable that the differences in the modes of applying this fubftance to ftiff adhefive foils, may have caufed the great diverfity in its effects which have been fo frequently noticed by practical writers.

As we have feen that there are confiderable differences in refpect to the purity or goodnefs of lime-ftone, or other calcareous matters, it is obvious that there muft be much variety in regard to the lime that is produced from them. Where it has been prepared from the purer kinds, when brought into the ftate of powder by being faturated with water, it is perfectly foft, fmooth, and impalpable ; while in other cafes it feels coarfe and gritty, according to the different degrees of impurity. In general, fo far as the purpofes of agriculture are concerned, that lime which has the greateft levity, is the fofteft and fmootheft to the touch, and has the whiteft colour, is the moft advantageous †.

* See Anderfon's Effays, vol. I. p. 537.

† The following criteria and analyfis have been offered by Doctor Anderfon, in his Effays, vol. i. p. 514, in order to judge of the goodnefs of lime : "If," fays he, "the lime-ftone lofes much of its weight in calcination, and the lime-fhells are extremely light; if the fhells require a very large proportion of water to flake them fully; if it is long before they begin to fall; if the lime-ftone is not apt to *run* (or be vitrified) in the operation of burning; if it falls entirely when it gets a fufficient quantity of water, after it has been properly calcined; if it fwells very much in flaking; and if the lime is light, fine to the

In the carriage of lime for the ufes of the farmer, it may fometimes be neceffary, where the diftance is confiderable, to pay attention to the nature or ftate of it, as without that much expence may be incurred to no purpofe. When the lime is pure, it will be the moft economical method to convey it in the ftate of fhell, as by that means nothing will be carried but what is ufeful; whereas, if it was carted in a flaked condition, a large proportion of water, and other matters, muft be conveyed with it. But where lime is impure, and adulterated with other fubftances, or imperfectly prepared, it may be a more faving method

touch, and of a pure white, the farmer may be fatisfied that it is extremely good, and may ufe it in preference to any other lime that is inferior to it in any of thefe refpects. Thefe rules are, he thinks, perfectly fufficient to decide as to the comparative value of any two kinds of lime that may be oppofed to one another, and may be relied upon as fufficiently accurate for the ordinary purpofes of the farmer. But that fuch as may difcover a new quarry of lime-ftone, and who wifh to afcertain with certainty its real value, before they put themfelves to any expence about it, will do well to employ the following more accurate, and, in that cafe, more cafy analyfis. As all calcareous matters are capable of being diffolved in acids, and as no other earthy matter can be diffolved in them, it follows, that if a fufficient quantity of acid is poured upon any body that contains calcareous matter, this matter will be quickly diffolved, while the others are left behind; and the proportions of each may be accurately afcertained. To try the exact value of any kind of lime-ftone, or other calcareous matter, take a quantity of aqua fortis, or nitrous acid, or fpirit of falt, or muriatic acid. It may be obferved, that all the mineral acids effervefce and unite with calcareous earths. But as the fulphuric or vitriolic acid (fpirit or oil of vitriol) does not *diffolve* the calcareous matter, but forms a new concrete that ftill retains its folid ftate, it is not fit for this experiment. And as it fometimes happens that a little vitriolic acid is mixed with either the nitrous or muriatic acids, it becomes neceffary to be certain that this is not the cafe before they are employed in this experiment. The eafieft way of trying if thefe acids are free from the vitriolic, is to put a little chalk into them before you employ them. If the acid is pure, the chalk will diffolve very readily; but if not, fome part of the chalk will fall to the bottom, in the form of a pure white fediment. When this is the cafe, add fmall bits of chalk, by little and little, till no more of that white fediment appears; after which, the acid may be kept for ufe, as fufficiently pure. If the nitrous acid is fo ftrong as to have a flight brown or reddifh appearance, it ought to be diluted with water till it affumes a greenifh look. As it is bought in the fhops, for the ufe of dyers, &c. it is ufually weak enough. If the muriatic acid is fo ftrong as to have a bright yellow colour, or emits fumes when the bottle is opened, it ought to be diluted by adding water, till it affumes almoft a colourlefs tranfparency, with a very faint tinge of yellow. When they are thus prepared (either of thefe acids may be ufed indifcriminately for this experiment, as they are equally proper), put them into a glafs or earthen veffel; add to that, by little and little, a known quantity of the matter you mean to examine, which had been previoufly dried and reduced to powder. After each addition, fuffer the violent effervefcence or ebullition that will enfue, to abate before more is added. When the whole of the powder is put to the acid, and the effervefcence entirely fubfided, ftir it about feveral times with a piece of tobacco-pipe, and allow it to remain for fome time, that the acid may act upon every particle of the matter, and thoroughly diffolve it: and to be certain that there has not been too little acid, put a few drops of frefh acid to the folution, which will excite a frefh effervefcence if the

to carry it in the ftate of powder; otherwife much matter may be conveyed that will never flake or fall down into lime*.

Lime may be employed in many different kinds of foil with advantage, when proper attention is paid in its application; but in its more active ftates it has been fhewn, by experience, to be the moft ufeful on thofe moory, peaty, heathy, and other foils which contain a large portion of coarfe vegetable matter.

From what has been obferved, it feems probable that lime, befides exerting its influence, when united with foils, in reducing the materials which they contain into the ftate or condition fuitable for affording the nourifhment of plants, and rendering them more proper for their reception, by altering their

whole is not fully diffolved. When no change is produced by this addition, it is a certain proof that the whole of the calcareous matter is already diffolved. Take then a piece of filtering-paper, thoroughly dry, the weight of which is alfo known; fold it properly, and put it in a glafs funnel; pour the whole of the folution, with the matter that may have fubfided, into the funnel, and allow it to filtre through the paper flowly. When the fluid part has thus drained off, fill up the filtre again with pure water, to wafh off the whole of the faline parts from the *refiduum*, or matter that remains undiffolved. Add water in this manner till it comes off without any faline tafte,—fuffer it then to drop off entirely,—dry it thoroughly,—and weigh the paper with its contents. The difference between which, and what the powder and paper were at the beginning, is the whole weight of the calcareous matter, fo that its proportion to the whole mafs is perfectly afcertained."

In this manner, he fays, he has examined a great many different kinds of lime-ftone, and has found them vary in all degrees of purity from fuch as were entirely foluble in acids, as fugar or falt is in water, to others that contained only one-twelfth of their weight of foluble matter, and eleven-twelfths of fand. The ordinary kinds of lime-ftone contain from one-third to two-thirds of their weight of fand. Hard chalk is ufually a pure calcareous earth, foluble in acids; and fome forts of lime-ftone may be met with that are equally pure, but thefe are rare. Were all the ftones in the fame quarry equally pure, the above would, fays he, be a perfect and unexceptionable method of afcertaining the purity of any lime-ftone; but it often happens, that in a quarry of the very worft quality, there are fome pieces found that confift of pure fpar, that are entirely free of any mixture of fand; and in other quarries of a better fort, there are often fmall veins of an impure fort of ftone, mixed through the rock; fo that if either of thefe fhould chance to be picked out as a fpecimen for trial, the refult would not be juft. To avoid falling into this miftake, any one who wifhes to make an accurate analyfis of any newly-difcovered lime-ftone will do well, he fays, to take eight or ten ftones from different parts of the quarry, that are fomewhat different in appearance from one another; and, having taken a chip from each, pound the whole together, to afford a proper fubject for the experiment. The fame experiment might be tried with *lime;* but it is evident the proportions would be different in the fame ftone, from what they would be if tried before calcination, as lime wants its fixed air, &c. which it had when in the ftate of lime-ftone. But as the lime is more liable to be varied by accidental circumftances, it is beft to try the experiment with lime-ftone.

* See Anderfon's Effays, vol. I. p. 509.

textures, or removing fuch qualities as are noxious, is capable of fupplying fuch matters as contribute to their growth and fupport. On this account it probably is, that it has been found by experience to be equally, if not more beneficial, on poor than on rich foils; and its requiring to be mixed and incorporated with but a fmall portion of earth or mould, to render it highly productive.

Lime-ftone, and other hard calcareous fubftances, without being fubjected to the procefs of calcination by heat, may, in many cafes, as where fuel cannot be procured to burn it into lime, be beneficially employed for the amelioration of land, as has been fhewn by the experiments of Monf. Du Hamel, and others. When thus ufed it fhould be well pulverifed, by fuch mechanical means as can be cheaply performed; much of the advantage to be derived from it probably depending upon its being reduced into a confiderable ftate of finenefs, by which it may be more minutely blended with the foils on which it is applied, and thereby act upon and afford nutritious principles more extenfively for the fupport of crops; and at the fame time render the heavy and more cohefive foils lighter, by being more uniformly incorporated with their clayey and earthy materials*. But as calcareous fubftances can never be reduced, by any fort of machinery, to the fine powdery ftate which they are capable of being carried by means of calcination,

* It is obferved by Dr. Anderfon, in his Effays, vol. I. p. 503, that he has feen the model of a mill that had been invented for this purpofe, which was conftructed on the fame principles with an ordinary gunpowder-mill. It had feveral large maffy ftampers, compofed of huge blocks of caft-iron, that were fucceffively lifted up and let fall by a wheel that catched their handles, and, after a proper time, flipped them again as it revolved round its axis. Thefe ftampers fell with great force upon the lime-ftone that had been previoufly broken into pieces of a moderate fize, and placed in a ftrong trough formed for that purpofe. Through this trough a fmall ftream of water was conveyed, which wafhed away with it the fmall pieces of lime-ftone, as they were fucceffively reduced to powder by the ftampers. This ftream of water was received into a large refervoir, in which it was allowed to ftagnate, and depofit as a fediment the lime-ftone powder it brought along with it; the pure water flowing gently over a part of the brim, which was made lower for that purpofe. When the refervoir was nearly full of this fine powder, the work was ftopped; the water was drawn off from the refervoir, by taking out fome plugs left for that purpofe, at different heights, till all that was clear had run off: the powdered ftone was afterwards thrown out to the bank, and allowed to dry fufficiently for ufe. He has, he fays, alfo heard that a mill, upon thefe principles, was erected by the Honourable the Truftees for managing the forfeited eftates in Scotland, and that a good deal of lime-ftone was pounded with it; but as it was erected in the Highlands of Scotland, where roads were bad, and where there was but little fpirit for improvements in agriculture, as there was no public demand for the manure, after the experiment was fufficiently tried to fhew that it might be practifed with advantage in other places, the mill was fuffered to lie unemployed.

it is probable that, when employed upon land, they will be lefs beneficial in many cafes, than when ufed in the ftate of lime. It is on the above principles too, moft probably, that the fcrapings of roads, made with calcareous and other fubftances, are found fo beneficial in different inftances, a large portion of them being in the ftate of an extremely fine powder, from the attrition of the wheels of carriages, and other caufes.

The experiments of Mr. Tennant, which have been already noticed, fuggeft, that even where magnefian lime-ftone is made ufe of in this ftate of reduction, without being converted into lime, it may not be fo friendly to vegetation as that which is perfectly calcareous, efpecially when employed in the fame proportions; a circumftance which may, in fome degree, account for the difference which has been obferved in the utility of fuch fubftances as manures. Such lime-ftones as contain the largeft proportions of argillaceous earth in their compofitions, when employed in this reduced ftate, will be the moft proper for the thin light foils; as by that means the ftaple of them may be increafed to the great advantage of the crops. In the application of this fort of material to land, the farmer fhould conftantly be attentive to the ftate or condition to which it is reduced, as well as the nature of the foil, and put it on in fuch proportions as may be moft fuitable to them.

Lime-ftone gravel, a fubftance which has been fuccefsfully laid upon land in Ireland, and which is a kind of ftony marle, might moft probably be equally or more beneficial, in confiderably lefs quantities, if the ftony lumps which it contains were firft more perfectly reduced; for it has been remarked, that where the pieces are large, a much greater proportion is required, and the effects are flower than where they are fmall.

Chalk is another material of the calcareous kind, which is capable of producing good effects on land, when applied in a fuitable manner in its uncalcined ftate. From its having a portion of argillaceous or clayey matter united with it in fome cafes, it partakes of the nature of marle. Where it is made ufe of to the more ftiff, clayey, loamy, and heavy forts of foil, it fhould, in moft cafes, be as much pulverized and reduced as poffible before it is laid on, in order that it may be fpread with greater exactnefs, and be more regularly mixed and blended with the ftiff and compact materials of fuch lands; from which they may be rendered more capable of admitting the fibrous roots of vegetable crops to fpread themfelves in them, and thereby take in more perfectly the nutritious matters which are prefented to them. That this practice is of much utility and advantage, is evident from the circumftance of farmers, in moft of the diftricts where chalk is

employed as a manure, finding that it is confiderably more beneficial when made ufe of in the fpring, after having been dug up in the autumn, and expofed to the froft and moifture through the following winter, and by that means much pulverifed and broken down, as well as by their carefully breaking and reducing the larger pieces. It would probably, however, be a ftill more advantageous practice to break it down, and apply it as quickly as poffible, after digging it out of the pit; as by leaving it expofed to the atmofphere for fome length of time, it not only becomes hard, but likewife lefs foluble, and therefore lefs proper for the purpofes of manure. Hence it probably is, that farmers, where the chalk hufbandry is practifed, find the dreffings more efficacious when the chalk is dug from a confiderable depth, than where it lies near the furface of the ground. In the dry and light foils too it may, probably, be more ferviceable in this reduced and powdery ftate, from the circumftance of its poffeffing more moifture, on account of a more extended furface being expofed to the air, and the particles of the foil, from which it may abforb and attract it, and afterwards part with or afford it in a more regular and uniform manner to the abforbent roots of the growing vegetable crops. The obfervations of practical farmers, however, invariably fhew, that on fuch foils it is much more beneficial when made ufe of in the form of compoft, either with rich peat or vegetable earth and mould, or with good dung; as by this means a great defect in fuch kinds of land, the want of well reduced vegetable matter, is remedied, and a greater proportion of nutritious materials afforded for the fupport of crops.

When this manure is employed upon the more wet and poachy kinds of ground, there is probably not the fame neceffity for its being reduced to a great degree of finenefs, as it may be apt, under fuch circumftances, to diffolve, and fink down too much by being fo greatly diluted with water, while in the rounder ftate it may be retained nearer the furface, and thereby be capable of abforbing and taking away the fuperabundant furface moifture more effectually. But even in fuch foils, where the principal intention is the deftruction of mofs, rufhes, and other coarfe plants, the growth of which depends upon a great degree of fuperficial wetnefs, it may be employed moft advantageoufly in a ftate of confiderable reduction, as from its greater readinefs to fink down, it may the more quickly take away from their roots the exceffive moifture that fupports them. It may, perhaps, neutralife acids too, when they exift under certain combinations in thefe foils, more readily when applied in its comminuted or pulverifed ftate than in the lumpy one in which it is commonly ufed.

The proportion in which this fubftance is to be applied to the ground muft depend, in a great meafure, upon the ftate of the foil, the nature of the crop,

and the purpofe for which it is employed. In many of the fouthern counties it is laid on the ftiff clayey foils in large quantities, as from twelve to fourteen or fifteen waggon loads, of from fifteen to twenty hundred weight each, to the acre; and on the fandy foils in fome parts of Kent, at the rate of one hundred and fixty bufhels to the acre.

On the deep and ftronger kinds of foil, the practice is commonly either to lay it on the clover leys while feeding off, or upon the fummer fallows. And in the form of compoft it is frequently ufed on the light foils, both to the fallows for wheat, and the grafs lands.

As chalk cannot, by any means, be reduced to that ftate of powdery finenefs that is the cafe with lime, and confequently cannot be fo equally fpread out, or fo minutely blended with the foil, it is evident that much larger proportions of it muft be employed to produce the fame effects on the foil; perhaps feldom lefs than three or four times the quantity will be required.

Where chalk muft be carried from a great diftance in its wet, heavy ftate, it will generally be the moft economical practice to have it firft converted into lime.

Marle is a calcareous fubftance, found under very different forms, and in different places, and made ufe of as a manure with much advantage, both on the thin light foils, and fuch as are more heavy and compact. It is diftinguifhed, from its particular appearances, into *fhell*, *clay*, and *ftone* marle. The firft is evidently of animal origin, from its being compofed of teftaceous or fhelly matters, in greater or lefs degrees of attenuation, from the gradual decompofition which they have undergone during the fucceffion of ages, with a fmall portion of earthy fubftances mixed and blended with them. It is conftantly found in fuch fituations as have been covered with water, from which, as the fediments or depofitions of mud or other earthy materials, in fuch cafes, muft have been different from various caufes, fuch marles muft be more or lefs pure, or contain greater or lefs proportions of calcareous matter, according to fuch circumftances; in general, however, they contain a larger proportion than the ordinary forts of lime.

In the fecond kind there is much clay ufually combined with the calcareous matter, from which circumftance it abforbs and retains moifture more ftrongly than moft of the other kinds. The clayey forts of marle vary greatly in refpect to their colours, being met with both of a brown, blue, red, and yellow tinge; and the ftone marle has different proportions of fand united with the calcareous matter and the clay, upon which depends the differences in regard to its hardnefs. Where this fort of marle has a thin laminated ftructure and flakey appearance, it is frequently denominated *flate marle*. From the portion of

clay that is contained in thefe marles, they become capable of being gradually foftened by the action of water, and ultimately fall down into the powdery ftate. All marles contain fome portion or other of clay, in combination with the calcareous matter, as has been long fince fhewn *, while in lime it is moftly fand which is united with that fubftance †.

But notwithftanding thefe differences in the appearance and conftitution of marles, they all agree in being reduced into a pulverulent or powdery ftate, by expofure for fome length of time to the influence of the atmofphere, by which means they are rendered ultimately capable of being intimately blended with the different materials of the foils upon which they are applied: but as this general property of falling down into fmall particles, in confequence of the abforption of moifture and carbonic acid, or fixed air, from the furrounding atmofphere, is much greater in fome kinds of marle than others, it may caufe fome difference in their utility as manures. Where fubftances of this kind are laid upon land, for the purpofe of fupporting an immediate crop of either corn or grafs, there can be little doubt but that the moft crumbly, or thofe the moft readily reducible into a powdery ftate, are the moft proper; but where they are laid on with the intention only of affifting future crops, or of producing more lafting effects, thofe that are more hard, and lefs difpofed to fall into pieces, may be more advantageoufly employed. The former feems to be fhewn to be the cafe, by the common obfervation of practical hufbandmen in marling diftricts, that marle does not exert its full effects on the foil, until it has been well mixed and incorporated with it by frequent aration, and by the practice of letting it remain fome time on the furface of the ground, before it is turned down, from which it becomes much pulverifed and reduced; and

* Ainflie in Phyfical and Literary Effays, Edinburgh, vol. III.

† It is ufefully remarked by Doctor Wilkinfon, on the authority of the late able Profeffor of Chemiftry at Edinburgh, in the twenty-firft volume of the Annals of Agriculture, that as all marles effervefce, or raife up frothy bubbles, when acids are applied to them, and as water alone frequently produces the fame effects when poured on dry clay, it may be neceffary, in order to guard againft miftake in making trials upon fubftances fufpected to be marles, to let them remain a little time in mixture with water previous to their being fubjected to the teft of acids. The beft or richeft marles being fuch as contain the largeft proportion of calcareous earth, it frequently becomes a matter of importance to farmers to be able to afcertain the quantities, fome being found fo poor in this material as to have only a twentieth or thirtieth of their weight, in order to decide on their advantage in preference to lime, chalk, or other fubftances to be brought from a diftance. A fimple and eafy method, founded on the knowledge that this earth commonly contains about forty per centum of its weight of fixed air or carbonic acid, is propofed by the fame profeffor. It is merely by faturating the marle with the muriatic or fome other

the latter, by the circumftance of the harder forts of marle remaining a great length of time upon, or within the ground, before they are fully decompofed or broken down.

This kind of manure produces beneficial effects on moft forts of foil in its different forms; the fhell, ftone, and thofe kinds of marle which abound moft with calcareous earth, or which have fand in their compofition, are the moft adapted to the ftrong, ftiff, clayey foils, as by the infinuation of fuch matters they are not only rendered more light and friable, but a great part of the injurious moifture which they contain is removed. But thofe in which clay is confiderably predominant are found more advantageous in the light, dry, fandy, gravelly, and loamy foils, as by fuch fubftances the defects of lightnefs are remedied, and the neceffary moifture in fome meafure preferved. On the ftronger forts of loamy foil, clayey marle will moftly be improper, as it has much tendency to render fuch forts of land more wet and adhefive, by which they may be greatly injured. Thefe have been found to be the effects refulting from the application of it even upon a temperate loam, in fome parts of Suffex. And befides it is fometimes apt to bring up coltsfoot, a weed which is difficult to be eradicated *.

In the quantity or proportion of thefe fubftances that is applied, there is confiderable difference in different diftricts, a circumftance which, in fome degree, depends upon the nature of the foils; the heavy clayey or loamy requiring, in general, a much larger proportion than the light fandy or gravelly. The general quantity employed may probably be eftimated at from about two to four or five cubic roods of fixty-four yards to the ftatute acre, according to the ftate of the marle, and particular nature and condition of the grounds on which it is laid. It may, however, in many cafes, be the moft advifable practice not to apply too thick a covering at one time, but to have recourfe to light dreffings more frequently, as by fuch a method the fertility of the land may be better preferved and kept up, and the crops be rendered more abundant †.

acid, and marking correctly the lofs of weight which it fuftains by the extrication of the fixed air. Thus, if two hundred grains of marle be introduced into a veffel with a little water, and muriatic acid poured upon them until the bubbles ceafe to rife, the lofs of weight being then found to amount to forty grains, the marle contains one hundred grains of calcareous earth. The proportion of calcareous earth contained in different marles may alfo be determined by diffolving it by means of the muriatic acid, diluting the liquor with water, paffing it through a filtering paper, and then precipitating the calcareous earth from the clear liquid by a folution of fome fixed alkaline falt.

* See Middleton's Survey of the Agriculture of Middlefex, p. 312.

† See Holt's Survey of the Agriculture of the County of Lancafter.

This manure is employed both on lands in a courfe of tillage, and grafs lands, from different feed crops. On the former it is generally made ufe of as a preparation for barley, turnips, and other fimilar crops, or applied upon clover or other new leys, previous to their being ploughed up for wheat; in which modes of making ufe of it, the common practice is to leave it fpread out upon the furface for fome length of time before it is turned in, in order that it may be well reduced into a powdery form; for the more perfectly the marle is broken down and fpread out, the more effectual it is found in promoting the growth of the crops. In its application in the latter cafe, it is frequently laid on in too large quantities, or left too long in its lumpy ftate; from both which circumftances difadvantages are produced to the growth of the grafs, when either to be cut for hay or fed off by cattle: as by the former, where the marle contains much of the argillaceous material, a kind of cruft is formed that prevents its fpringing, as happens where the ftiff mud of ponds, and fuch-like manures, are too thickly laid on lands; and from the latter, the grafs is not only injured by the fmall clods, as is experienced where imperfectly reduced clayey earth is applied, but the effects of the manure are prevented from being fully exerted, on account of its not being well broken, and carried down to the abforbent roots of the graffes, by the frequent rains that may take place after its application.

Some farther attention feems likewife requifite in the ufe of this manure, as well as to the mode of cropping with it. When employed in large proportions, whether upon the heavier or lighter forts of land, a confiderable fpace of time appears, from experience, to be required to elapfe, before it can with advantage be had recourfe to again; for if this circumftance be not properly attended to, or too many white crops be fucceffively taken, a very great degree of exhauftion is foon produced, as has been experienced in many of the marling counties of England, and in Forfarfhire in Scotland. Thefe injurious confequences are, however, found to be eafily prevented, by adopting the alternating fyftem of corn and grafs, or other green crops. And it is probable that by taking corn and grafs crops in fucceffion, or, after having one or two grain crops, letting the land be laid down for two or three years with artificial graffes, the application of marle in fmall quantities might be more frequently renewed, to the great advantage of the farmer, and the improvement of the land. In fome of the places where this kind of manure is made ufe of, as in Lancafhire, fomething of this practice is adopted with much benefit. And

when mixed with dung and other fubftances, in the form of compoft, it is generally found capable of being repeated, at fhort intervals, with the moft beneficial effects. From thefe facts it would therefore feem probable that fuch injuries are rather to be afcribed to the mode of cropping, than to the nature of the manure. Something may alfo, perhaps, depend on the manner in which it is applied, as it has been found to be more efficacious when well mixed and incorporated with the foil, than where this has not been the cafe; and as it has been found highly advantageous in promoting and bettering the condition of the grafs lands in fome diftricts, while in others it has been objected to as injuring them, it is ftill farther probable that much depends on the ftate and manner of its being put in or upon lands, and that it is only where it is laid on in a moderate fuitable proportion, and after it has been well broken down and reduced into a fine powdery form, fo as that it may be very minutely and intimately blended with the foil, that its beft effects can be exerted.

The circumftance of this fubftance having been ufed with great fuccefs in fmall proportions, as eight or ten bufhels to the ftatute acre, after being burned in proper kilns, ovens, or other places, and well reduced into a fine powdery ftate, fo as to be fown with the hand over the crops, as a top dreffing, appears alfo to favour the fame conclufion *.

And the general practice of digging it up in the fummer months, and fpreading it over the ground in a lumpy ftate, in order that it may be acted upon and reduced by the heat of the fun and the frofts during the fucceeding winter, is likewife in proof of the fame thing.

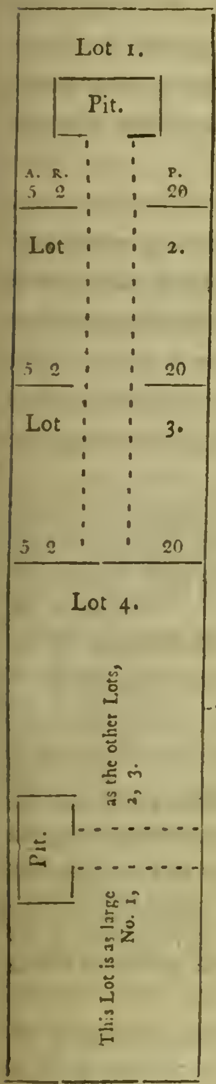
This kind of manure is frequently procured by loofening and undermining large maffes, and letting them fall down by forcing piles in above them; but great care fhould be taken in performing the bufinefs, as there is often much danger by the lumps giving way fuddenly. In fixing upon places for opening pits, attention fhould be had to the injuring of as little land as poffible, to having them as convenient as poffible for carriage, to their having the leaft difficulty of draught, and to the water that may ftagnate in them early in the fpring producing the leaft poffible mifchief afterwards. Such pits fhould, indeed, only be made as can be eafily laid dry†.

The expence attending the ufe of this fubftance as a manure, muft vary confiderably, according to the proportions in which it is applied, the facility with which it is dug from the pit, and the diftance which it is carried. In

* See Holt's Report of the Agriculture of Lancafhire. † Ibid.

this way it may vary from two to ſix or ſeven, and in ſome caſes twelve or fifteen pounds the ſtatute acre*.

* The differences in the expence from the circumſtances of conveying it from different diſtances, is thus ſhewn by Mr. Holt, in his Survey of the County of Lancaſter.



Suppoſe the Lot 1 be thirty rods ſquare, and the pit right in the centre, ſo that its greateſt diſtance from the pit be fifteen rods every way. The cartage will be 18s. per rod; and, to ſave fractions, call the field ſix acres; then the account will ſtand as under:

Cartage, per rod -	18s.
No. of acres - -	6
	108
No. of rods laid per every acre	6
	648

£.32. 8s. Total amount of expence of Lot 1.

Now, if Lot 2 be marled out of the pit in Lot 1, the additional expence will be 12s. per rod, or 54l. being forty-five rods from the pit.

And, if Lot 3 be to be marled ſtill from the ſame pit, the additional expence will be 26s. per rod, or 44s. the whole; the diſtance from the pit being ſeventy-five rods, and the expence 79l. 4s.

Again, Lot 4 being as large as the other three, and the pit in the centre, the extreme diſtance will be forty-five rods each way, and the cartage will be 21s. per rod, of ſixty-four cubical feet, and which will amount to 113l. 8s.

The comparative eſtimate ſtands thus: Lot 1, 32l. 8s.—Lot 2, 54l.—Lot 3, 79l. 4s. Total amount of which is 165l. 12s.—Three times 32l. 8s. is 97l. 4s.—Balance ſaved by having a pit in each field would, he ſays, be therefore 68l. 8s.—The expence of Lot 4 is 113l. 8s.; and from which ſubtract 97l. 4s. and the balance is 16l. 4s. The above will, he thinks, evidently prove the advantage of proximity to the marle: but a pit in the middle of a field is not only an eye-ſore, but a nuiſance; therefore, if poſſible, ſhould be avoided. Nor is the advantage ſo great in the middle as may be thought; ſince, in coming out of the pit, there being only one pace, ſome part of the ground muſt of neceſſity be gone twice over; whereas, if on one ſide of the field, and central, all the land lies immediately before the pace of the pit.

He ſtates the expence of marling upon Bootle Marſh, about the year 1780, to be as follows:

	£.	s.	d.
Getting and filling, per rod of 64 cubic yards - -	0	10	0
Spreading - - - - - -	0	2	2
Carting; the average diſtance from the middle of the pit to the middle of the land, 60 rods - - -	1	9	0
	2	1	2

In this calculation, he obſerves, there are ſix carts, five in motion, each goes the diſtance of twelve rods, whilſt one ſtands in the pit to be filled. The ſize of each cart is 20,736 inches (cubical),

In fituations where both this manure and lime can be procured, the choice fhould be regulated by the facility and cheapnefs of obtaining one in preference to the other, the ftates of purity in which they prefent themfelves, and the nature of the foils to which they are to be applied. Marle, where it contains much clay, may be preferable for a light fort of foil; while lime, as containing a larger portion of calcareous matter, may be more advantageous in fome clayey ftiff foils. The quantity or proportion of calcareous matter contained in different marles, may be afcertained by the methods that have been already given for lime-ftone.

The fhelly fand brought up and depofited in beds, in the crevices, and level parts of the fea coafts, is another fubftance capable of being employed with great benefit as a manure, not only on account of its containing calcareous matter in a fine attenuated ftate, from the rubbing down of fhells and other fubftances of the fame kind, but from the mixture of different animal and vegetable recrements with it, and a fmall portion of muriat of foda or fea-falt being retained. The laft, from its known property of promoting the

ufually drawn by three horfes; the weight of the load about 15 cwt. and two cubical yards of marle make about three loads. The number of workmen are fix fillers and getters; ufually two right-handed men at one wheel, and two left-handed at the other, with one filler behind: one getter is generally fufficient.

	£.	s.	d.
Getting, filling, and fpreading, to the acre of 64 yards to the rod, on Bootle Marfh, was	3	19	1
Cartage - - - - - - - - - - -	9	8	0
Digging for the marle, clearing the head, expences at finifhing, &c. per acre - -	2	7	0
	15	14	1

There were, he fays, about 6½ rods laid upon the acre on this occafion. The men got 2s. 6d. and the carts 7s. 6d. per day. Getting and filling marle, it is remarked, is very laborious work, and requires the utmoft exertion to obtain thefe wages; and that this work, after all, can only be effected by young men in their prime, cheered by the company of fellow-labourers, and frequent refrefhments. Five working days, he fays, are reckoned equal to fix at other work, for they ufually begin at half paft four in the morning, and reft one hour at breakfaft, from eight to nine; reft again from twelve till two, and then work till fix; and generally get out nine rods per week.

The prefent price (1795) is—	£.	s.	d.
For getting and filling, per rod - - - - -	0	12	0
Spreading - - - - - - -	0	2	6
Carting - - - - - - - -	1	13	0
	2	7	6

In the Middlefex Report it is ftated to be this—"Four men digging and filling eighty cart-loads, at 4s. a fcore, fpreading included, is 16s. One man and four horfes, two days, at 12s.—1l. 4s. Total expence per acre, 2l."

putrefaction and decay of animal and vegetable matters when in fuch quantities, as well as that of deftroying different kinds of living infects, may contribute greatly to the good effects produced by it. This, indeed, appears ftill more probable, from that which is taken from underneath the water, or from fuch banks and places as are daily covered by the tides, being the moft efficacious.

The proportion of calcareous matter contained in fuch fubftances muft vary very much according to the particular circumftances of the cafes, which can only be fully afcertained by fuch proceffes as thofe which have been propofed for lime. Where the quantity of calcareous matter is large, and in a very reduced or attenuated ftate, it is by much the moft valuable; as when there is much fand amongft it a much larger quantity will be required, and the expence of application be of courfe much increafed.

This fubftance feems more proper for the clayey or loamy foils than thofe of the lighter kinds, efpecially where the proportion of calcareous ingredient is large. When equally fpread, and well incorporated with fuch lands, it is generally found to produce goods effects for a great length of time.

It has been obferved that a confiderably lefs quantity of calcareous matter, when in this fine ftate, will have a more fenfible effect, than when it is in that of any kind of earthy marle, as it admits of being fpread over the ground with greater equality, and of being more minutely and intimately blended with the foil *.

The quantity employed muft obvioufly be different according to the circumftances and nature of the foil, as well as the fand; but twenty tons to the acre is, for the moft part, confidered as a proper dreffing. It is frequently applied on the fummer fallows for wheat, and fometimes as a preparation for barley; it may likewife be laid on the clover, or other leys, before they are turned down for grain crops, but in thefe cafes fo large a quantity is not neceffary. When put upon grafs land, in not too large a proportion, it commonly produces great and fudden effects, the crops quickly becoming very luxuriant. It is alfo obferved, that fuch lands as have been treated in this way, when again brought into tillage, moftly produce abundant grain crops.

The effects of this fort of manure on the weft coafts of the northern parts of the ifland, have been very extraordinary, efpecially upon the heathy or moffy foils; and it is fuppofed that fuch kinds of fand are more common on the eaft coafts than has been generally fuppofed †.

* See Anderfon's Effays, vol. I. p. 562. † Ibid, p. 563.

A fhelly kind of fand, which in digging up appears with blue veins, has lately been ufed in fome parts of Lancafhire as a fubftitute for marle with confiderable fuccefs *.

It feems not improbable but that oyfter as well as other kinds of fhells, if they were fufficiently reduced by fuitable machinery, might be of great ufe as a calcareous manure for the heavier forts of land. When met with in large maffes, or extenfive beds, it might probably, in fome cafes, be economical to calcine them, and apply them as lime, either in the fimple ftate or that of combination with earthy materials.

Common fand can fcarcely be confidered as a manure, but it is frequently found ferviceable in the ftiff, clayey, and loamy foils, in leffening their tenacity, and rendering them more friable and mellow. It has been laid upon rough pafture and meadow land, in large quantities, with excellent effects, rendering the furface more equal, and bringing up a clofe thick crop of grafs with much white clover. The quantity muft be proportioned to the ftiffnefs of the foils; it is, however, probably better not to apply too much at one dreffing.

MANURES FROM THE *AGENCY* AND *DECOMPOSITION* OF *SALINE SUBSTANCES.*

Substances that contain much faline matter in combination with their earthy and other ingredients, are found, in many inftances, when properly employed as manures, to contribute greatly to the fupport of vegetation. The materials principally made ufe of in this way are the refufe of different manufactures, fuch as bleaching and foap-boiling, where they can be procured in fufficient quantities, as in the vicinity of large towns, and where fuch manufactories are carried on in an extenfive manner; the afhes remaining after the combuftion or burning of various green vegetable matters, wood, pit-coal, peat, &c.; and fome other fubftances, fuch as foot and fea-falt.

It is moft probably to the different alkaline principles contained in thefe fubftances, from the great facility and power which they poffefs of acting upon and diffolving the parts of animal and vegetable matters, efpecially fuch of the latter kind as have been rendered infoluble by the abforption of the oxygen, or pure air of the atmofphere, from long or frequent expofure to it, and even foffil coal under fimilar circumftances, and by this means forming new faline

* Holt's Survey, p. 126.

compounds which are ſoluble, that their beneficial effects as manures are chiefly to be aſcribed*. The ſame author alſo remarks, that as ſuch inert or inſoluble vegetable or peaty matters, when decompoſed or reduced into a ſtate of ſolubility by alkaline ſubſtances, aſſume a browniſh-red colour, and become inſipid; the alkalies, in ſuch caſes, muſt enter into combination, and be neutraliſed by the acid or acids contained in them, which will be found to be the phoſphoric and the oxalic, or acid of ſorrel; from which will be formed, according to the nature of the alkali contained in the ſubſtance made uſe of, phoſphats and oxalts of pot-aſh, ſoda, or ammoniac, which are matters capable of promoting the growth of plants.

But theſe ſubſtances, beſides their forming in the ſoils, or the earthy materials with which they are mixed, ſuch compounds as are beneficial in promoting the growth of vegetables, may be uſeful in many caſes when properly applied, and uſed in ſufficient quantity, in correcting acidity, in altering the ſtate or condition of the lands, as by the taking away of moiſture from the ſurface where it prevails in an over-proportion in meadows and paſtures, and thereby ſupports crops of coarſe vegetables, and by rendering the texture of ſuch grounds as are under the plough more open and friable, conſequently more ſuitable for the reception of the roots of corn corps.

The refuſe of bleachers contains vegetable and mineral alkali, in ſuch proportions as render it incapable of being employed without being previouſly mixed with other materials; for which purpoſe, freſh mould or peat earth ſhould be procured; and after having been well mixed and blended with it, in the quantity of about eight or ten parts of the earth to one of the refuſe, a proportion of rotten dung ſuitable to the purpoſe for which the manure is intended, may be added, by which means a good manure will be formed.

The waſte of ſoapers is another ſubſtance that may be made uſe of in the ſame way; but in this there is a conſiderable portion of lime, mixed with the alkaline matter. The lees, or liquors, which are drawn off after the making of ſoap, as containing much alkaline ſaline matters, may likewiſe, where they can be procured in ſufficient quantities, and at a reaſonable rate, be made uſe of in the ſame manner.

All theſe ſubſtances, when combined with rich vegetable mould, or peaty matters, and made uſe of as manure, are found to be the moſt advantageous and uſeful upon the ſtiff clayey and loamy ſoils; as in ſuch ſorts of land they probably not only contribute to the increaſe of the crops by furniſhing ſuch ſoluble

* Dundonald on the Connection of Agriculture with Chemiſtry.

matters as can be readily taken up by their abforbent roots, but, by leffening their ftiffnefs and tenacity, render them more proper for their reception.

The quantity of thefe manures which is neceffary, muft, as in moft other cafes, be various, according to the particular circumftances of the land upon which they are applied, and the views of the farmer.

They are laid upon lands in the ftate of tillage, as well as thofe under grafs; in the firft cafe they are moftly either put on in the ftate of compoft, at the rate of about ten loads to the acre, juft before the feed furrow is given, or fown upon the furface, and harrowed in with the grain; but in whichever way they may be applied, it will be requifite to have them fpread as equally as poffible, in order that they may produce their effects in the moft extenfive and perfect manner; and in the latter, though they may in fome inftances be ufed alone, it is probably a much better practice to have them mixed with fuch earthy fubftances as have been defcribed, before they are applied to the fwards, as by fuch a practice their effects as a manure may be rendered more complete and lafting. To grafs lands they are frequently ufed to the amount of from one hundred to one hundred and fifty bufhels. And moft grafs lands are improved by the application of fuch manures, but efpecially fuch as are wet and difpofed to the production of coarfe four vegetables, fuch as rufhes, wild forrel, &c.

The afhes, or earthy faline matters, which remain after the combuftion of different frefh vegetable products, are all of them beneficial when judicioufly employed as manures; but as this means of producing manure is much too wafteful and uneconomical a practice to be adopted, except in particular inftances, as where wood and other vegetable productions are very abundant, and ufed commonly as fuel, or where they cannot be readily cleared away by other more advantageous methods, as ten or fifteen parts, and in fome cafes confiderably more, of fuch materials are diffipated and loft during the procefs, they can but feldom be made ufe of in the way of dreffings for land. Where they can be procured in fufficient quantities for thefe purpofes, they may, probably, be employed to the greateft advantage by being mixed with a good portion of rich vegetable mould, or peat earth, and a quantity of well-fermented dung; as, in fuch a compound ftate, they are capable of being applied more extenfively, and at the fame time in the moft favourable condition for the fupport of vegetation. When made ufe of on the heavy foils, the quantity of afhes in the compoft fhould be much greater than on thofe of the lighter kinds; they are, in general, the moft effectual when applied as a top dreffing to grafs lands, efpecially fuch as are commonly termed four, or have much tendency to the production of mofs.

Peat-earth is a ſubſtance met with in many diſtricts, and which after being cut and exſiccated by the heat of the ſummer, is made uſe of as fuel in ſuch places. By the conſumption of peat in this way, a very conſiderable loſs, ſo far as manure is concerned, is however ſuſtained; as, in many caſes, nineteen parts out of twenty of the material is diſſipated and carried away in the proceſs of combuſtion, which, as it has been ſhewn, that the inert vegetable or peaty matter, produced by the action of oxygen, or the pure air of the atmoſphere, for a great length of time, is capable of being rendered ſoluble, by mixing lime in certain conditions with it, and ſtill more effectually by alkaline ſaline ſubſtances, might have been preſerved and rendered uſeful as manure *. In ſome places however, as in Berkſhire, it is the common practice to dig up peat-earth, merely for the purpoſe of burning it into aſhes, in order that it may be uſed as a manure.

As freſh or green vegetable productions are only capable of yielding alkaline ſaline ſubſtances when burned, none being afforded by the combuſtion of dead or decayed vegetable matters, it ſeems probable that the aſhes of peat-earth ſeldom contain much ſaline matters. It is however obſerved by ſome writers, that all peat-earths afford alkaline ſaline matters in a greater or leſs proportion when burned, and that in ſome it is from a twenty-ſecond to a thirty-ſecond part of their weight †. The aſhes produced from the burning of peat about Reading in Berkſhire, which long experience has ſhewn to poſſeſs great fertilizing powers, are aſſerted to contain no alkaline ſalts, nor, from the haſty analyſis of them which was made by the writer, any ſaline matter, except a ſmall proportion of ſulphat of magneſia or Epſom ſalt ‡. But it is added, that if the analyſis had been more carefully made, and when the aſhes were newly burnt, they would moſt probably have been found to contain a hepar of lime, which is a ſaline ſubſtance ſoluble in water, while gypſum, the ſubſtance to which it returns on being expoſed to the air, is inſoluble. The fertilizing effects of theſe aſhes may, therefore, probably materially depend upon this hepar of lime. This is rendered ſtill more probable from the obſervation, that " the hills on each ſide of the meadows which produce the Newbury *peat-aſhes*, conſiſt of chalk, eaſily diſſolvable by heavy rain, which waſhes it off the ridges down the furrows, ditches, and ſtreamlets, to the low grounds, where mixing with the floods, it is floated over

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 108.

† Millar's Dictionary, art. Manure.

‡ Dundonald on the Connection of Agriculture with Chemiſtry, p. 106.

the meadows, and depofited in the peat. Confequently that the peat of this diftrict differs from that of moft others, by the quantity of chalk which it contains; and, when dug, dried and burnt, the fire reduces the chalk to lime, and the reft to afhes. Hence Newbury afhes are a mixture of lime and vegetable afhes; and that it is very probable that any common peat-afhes, or the afhes of rough grafs land, of turf, heath, furze, ling, wood, &c. produced by the operation of paring and burning, being mixed with chalk lime in due proportion, would be as equally fertilizing as thefe noted afhes *."

There is another circumftance that may caufe a difference in the faline and other fubftances contained in the afhes of different peaty earths, which is the prefence of mineral fprings. When, by this means, an over-large portion of fulphat of iron, or green vitriol, happens to be prefent in the peat, the afhes produced from its combuftion muft, in confequence, become injurious, or at leaft much lefs beneficial to the growth of vegetables, than in cafes where it does not exift.

The prejudicial effects of this fubftance may, according to the obfervations of Lord Dundonald, be corrected by the ufe of either lime, magnefia, alkaline falts, or dung; but that preference is to be given to magnefia and alkaline faline fubftances, as they not only decompofe the vitriolic falt, but form Epfom and Glauber falts, or vitriolated tartar, fubftances which have been found to promote the growth of vegetables.

When dung is made ufe of, the vitriolated iron is brought into its metallic condition, and the fulphuric acid, thus fet at liberty, combines with the ammonia or volatile alkali produced from the dung, and forms fulphat of ammonia; or it may, by uniting with the calcareous matter, and by the additional affiftance of the inflammable or putrefcent matter of the dung, be converted into a hepar that may be ferviceable in vegetation.

Peat-afhes may be ufed as a manure, either by being harrowed in with the grain, or fown as a top dreffing after the crops have come up; in the former cafe they fhould be employed in a fomewhat larger proportion than the latter. In the latter method of ufing them the beft practice is to fow them over the crops before they are grown too high; and if the weather be rather inclined to wetnefs, it will be the more favourable: the quantities commonly employed in thefe cafes are from fifteen to twenty bufhels the acre, according to the ftate or

* Middleton's View of the Agriculture of Middlefex, p. 298.

condition of the land. When laid on graſs lands, whether thoſe of the artificial or natural paſture kinds, theſe aſhes frequently effect great improvements, rendering the graſſes both thicker and finer.

Peat, in the reduced ſtate of duſt, is ſometimes alſo made uſe of with conſiderable benefit; but it would ſeem that this ſort of earth may generally be employed to moſt advantage by being well mixed and incorporated with ſuch ſubſtances as contain alkaline ſalts, or with alkaline hepars, or by a mixture of ſulphat of ſoda, or Glauber ſalts, with lime in its active ſtate *. The powdery or duſty matter of pit-coal might, likewiſe, probably be uſed with the ſame advantage if prepared in a ſimilar manner, as it is capable of being rendered ſoluble by ſuch means.

It is aſſerted by the ſame ingenious author, as the reſult of experimental trials, that the effects of peat-earth, mixed and incorporated with alkaline ſaline ſubſtances, are equal, if not ſuperior, to thoſe from dung, the weight of each being the ſame†. If this fact be well founded, the advantage of employing peat-earth in this way, inſtead of converting it into aſhes, is ſtill greater than has been ſuppoſed above.

The aſhes of pit-coal, where they can be procured in ſufficient quantities, as in large towns where it is principally employed as fuel, are, when applied as manures, found to be uſeful in many reſpects; but as theſe can contain ſaline matter only in proportion to the quantity of freſh vegetable products that may have been conſumed along with them, little of the effect which is produced by them can depend upon it; much more, probably, ariſes from the portion of calcareous earth which they contain. Something too, in many caſes, probably depends on the animal ſubſtances that may have been occaſionally burnt, or afterwards mixed with them, before they are made uſe of as a manure. They may alſo be ſerviceable on the ſtiffer ſorts of ſoil, by rendering them more open and diſpoſed to admit the roots of growing vegetables. That they may be beneficial in theſe ways ſeems to be ſhewn by their utility in the ſtiff clayey grounds from which brick-earth has been dug, and on what are generally termed ſour lands. On the more tenacious loamy ſoils they may operate by giving friability, and at the ſame time the calcareous principle, in a ſmall degree, when it is deficient. This is a concluſion which is further ſupported by their having been found from experience to be much leſs uſeful in the poorer ſorts of land.

By the application of theſe aſhes, in the vicinity of London, to the ſtiff ſoil

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 108.

† Ibid, p. 183.

from which the brick-earth has been taken, they render it fufficiently friable to afford a good crop of beans, a vegetable which, though it grows well on the heavy foils, could not otherwife be produced on lands fo very ftiff as the bottoms of brick grounds generally are found to be. After this crop has been t ken, it is generally found that fuch grounds are in a condition to admit of grafs feeds being fown with the fucceeding crops. But, except in fuch cafes as the above, this manure is probably the beft adapted to grafs lands as a top dreffing; it may, however, occafionally be ufed in this way to the young grain crops. The proportion which is neceffary muft be different according to the intention of the farmer, the nature of the crop, and the ftate of the land.

Soot is another fubftance that experience has fhewn to be of confiderable utility, where it can be collected in fufficient quantities and applied to land as a manure. The beneficial confequences refulting from the ufe of this fubftance depend, probably, in a great degree, on the quantity of alkaline faline matter which it contains; which, by its action on the rich vegetable mould of the foil or earth with which it is mixed, may render it more capable of fupplying the nutrition of plants; and it may bring the thick oleaginous matter of the foot into fuch a ftate as to be capable of folution or diffufion in water, and thereby in a condition to be taken up by the abforbent roots of vegetables. The earthy matter of this fubftance, as well as that of different kinds of afhes, may probably be rendered more fuitable for the purpofe of promoting vegetation, by their having been expofed to the action of fire, as is well known to be the cafe with clay. The great ftate of tenuity or finenefs in which foot is found may, likewife, be ferviceable, as by that means it becomes capable of being more regularly and more extenfively mixed with the foils on which it is applied. Indeed the good effects of moft fubftances employed as top dreffings depend, in fome meafure, upon this circumftance.

Soot, as it contains alkaline falt in a confiderable proportion, might probably be ufed with greater advantage by being well mixed or blended with rich mould, or peat-earth, and by fuch a method the quantity of manure would be greatly increafed. This fhould not, however, be attempted where the deftruction of infects forms any part of the defign of the farmer.

This manure is chiefly made ufe of as a top dreffing to grain crops and grafs lands. On the former it has been found extremely ufeful in deftroying the wire-worm and other deftructive infects. This is probably effected by the bitter oleaginous liquid formed from the union of the alkali and the oil of the foot, impregnating thefe parts of the plants on which they feed, and

thereby caufing them to be rejected by fuch infects. It may alfo produce fome advantage in this refpect by promoting a rapid vegetation, and thereby rendering the texture of the plants, very quickly, too firm to be preyed upon by them*. That foot is very powerful in promoting the vigorous growth of vegetable crops, is evinced by the change which takes place after fowing it over fuch young wheat crops as have a yellowifh fickly appearance, as they frequently put on, in a very fhort time afterwards, the healthy green afpect. On meadow and pafture lands experience has likewife fhewn it to be highly ufeful, not only by encouraging the growth of a finer fort of grafs, but by deftroying or correcting the frequent difpofition of fuch grounds to produce mofs, and fome other coarfe forts of vegetable productions. The proportion of this, like that of all other manures, muft vary according to the circumftances of the cafe. The common quantity is generally from about forty to fifty bufhels on the acre.

Where afhes, foot, or any other material that contains faline matters, are to be employed as manures, they fhould always be preferved in fheds, or other convenient places, from rains, or the accidental application of water to them, as where this practice is neglected the faline fubftances are foon diffolved and carried away in a liquid form. It is chiefly from this caufe that fubftances of this kind which have been long expofed without being covered, are often found fo inferior in their effects to thofe which are frefh or newly made. On this account alfo, if fuch fubftances are laid on land at too early a period of the feafon, they will be liable to have much of their valuable properties carried away by the rains that may take place.

Muriat of foda, or fea-falt, is a fubftance, the utility of which, for the purpofes of manure, feems not yet well afcertained, as by fome writers it is confidered as poffeffing confiderable powers of promoting vegetation, while others have experienced little or no advantage from its application; but as the experiments of Pringle and Macbride fhew, that though it may prevent putrefaction when employed in large proportions by its antifeptic property, yet that when ufed in fmall quantities, it has evidently a tendency to promote the procefs. On this account it may therefore be ferviceable when incorporated with farmyard dung, and other animal or vegetable matters, in fmall portions.

It is alfo thought probable by an ingenious writer, that from calcined clay, as it is met with in the more loofe and foft kinds of bricks, having a power of decompofing fea-falt—as is fufpected from the circumftance of his having re-

* Dundonald's Connection of Agriculture with Chemiftry, p. 138.

marked in a cellar where ſalted meat had been kept for a great length of time in a ſalting-tub, which was attached to one ſide of the wall, that on the other there was a great effloreſcence, which he conceived to be natron or foſſil alkali—it may, when more tardily combined with oxygen, by expoſure to the air, from the different proceſſes of cultivation, poſſeſs the ſame property; and that the great diverſity and contradiction that has been obſerved in the effects of ſea-ſalt may have depended on this circumſtance, as it might thus be highly uſeful on clayey ſoils, though it was of little or no advantage to others *.

It is alſo further ſuppoſed, by the ſame author, that as common ſalt is a ſtimulus which affords little or no ſupport in the way of nouriſhment, but which may excite the abſorbent veſſels of vegetables to exert themſelves more powerfully, it may, in a certain proportion, augment their growth by inducing them to take up a greater quantity of nutrient matter in a limited time, and to perform their circulation and ſecretions more vigorouſly. But that in a large quantity its ſtimulant powers may be ſo great, as to deſtroy them by exhauſting the irritability of their veſſels, as has been found by Mr. Van Uſlar, in watering plants with oxygenated muriatic acid.

Theſe circumſtances probably further explain the reaſon why ſea-ſalt, when made uſe of in large proportions, is frequently injurious to land, and the growth of crops; while employed in ſmall quantities it produces highly beneficial effects.

This ſubſtance may likewiſe be uſeful in other ways, as, from its known power of deſtroying various kinds of inſects, ſuch as worms, ſlugs, grubs, ſnails, &c. a power which an able writer ſuppoſes to depend on the exciting of greater evacuations from their bodies than they are capable of withſtanding, much nutrient matter may, in different caſes, be provided for the ſupport of vegetation †.

As every-where in the vicinity of the ſea a ready means of obtaining this ſaline material in unlimited quantities offers itſelf, it may deſerve more particularly the notice of the agriculturiſt; and more eſpecially as many other ſubſtances that are known to contain or be impregnated with it, ſuch as the weed thrown up by the tides, and the ſand over which they flow, can be eaſily procured.

The bittern, waſte, or refuſe, of ſalt-works, which generally contains muriat of magneſia in large proportions, is found to poſſeſs very great ſceptic qualities, and

* Darwin's Phytologia, p. 226.

† Dundonald on the Connection of Agriculture with Chemiſtry, p. 138.

may therefore be highly uſeful when mixed with dung, or earthy matters. The experiments that have been made with this ſubſtance likewiſe ſhew it to be capable of promoting vegetation in a conſiderable degree.

But in whatever way ſubſtances of the ſaline kind may produce their effects in promoting vegetation, when employed as manures, it is evident, from their containing in themſelves little or nothing of ſuch matters as are capable of affording nouriſhment to plants, that they may, in moſt caſes, be made uſe of to the greateſt advantage by being mixed and incorporated with ſuch ſubſtances as they are capable of acting upon and reducing to a ſtate proper for the ſupport of vegetable crops; ſuch as rich earthy materials, imperfectly reduced dung, and other matters of a ſimilar kind. Where ſubſtances that contain the muriat of ſoda, or ſea ſalt, are employed, if the opinions which have been ſtated above be correct, they might probably be applied to much advantage by being mixed with imperfectly burnt clay, when reduced to the ſtate of powder. And if, upon trial, they ſhould be found effectual in this form, they might be very conveniently made uſe of in the way of top dreſſings to graſs or grain crops in the ſpring.

MANURES FROM THE *COMBINATION* OF *DIFFERENT SUBSTANCES.*

It is evident, from what has been already obſerved on the nature of the different ſubſtances that are capable of being made uſe of as manures, that they may frequently be mixed and blended with each other, or with ſubſtances of other kinds, and by ſuch means be not only conſiderably increaſed in quantity, but in many caſes rendered more effectual and more ſuitable for application than in their ſimple ſtates; but at the ſame time, that ſome of them may be mixed and incorporated in this way with much more advantage than others: for, though the general experience of farmers has fully ſhewn the great importance and utility of employing compound manures, or compoſts, little attention has, till lately, been paid to the compounding or mixing together of ſuch ſubſtances as are, from the principles which they originally contain, or which are formed from them in the changes which they undergo in the different ſtages of their decompoſition, adapted to act in the moſt ſuitable manner for producing ſuch combinations or alterations in the materials, as are capable of being beneficial in the promotion of vegetation when they are employed as manures.

Farm-yard manure, which is the moſt general application of any, from its

being formed by the decay of various kinds of vegetable matters, ſuch as hay, ſtraw, fern, and many other materials of a ſimilar nature, with which the dung and urine of animals is incorporated and combined, muſt be conſidered as a compound ſubſtance. And from the large proportion in which ſuch vegetable productions enter into its compoſition, and the quantity of earthy materials that is in moſt caſes, eſpecially where the management is upon a judicious plan, added by the laying of ſuitable bottoms, it is not ſo frequently neceſſary to be blended with other ſubſtances that are uſually employed in forming compoſts. But from moſt of the vegetable materials that conſtitute the chief part of this ſort of manure, being made uſe of in a dry and hard ſtate, they do not ſo quickly ferment or run into the ſtate of decay, notwithſtanding the proportion of animalized matters that may be mixed with them; it therefore becomes an uſeful practice to turn them over, by which their complete putrefaction may not only be promoted, but the different materials be more minutely blended together, on both which accounts they may become more uſeful when applied as manure upon land. In the forming of this manure, care ſhould alſo be conſtantly taken that the heaps be ſo ſituated as that they may not become too dry, or too much ſoaked in water, as in either caſe they muſt be greatly injured. Whenever it may be requiſite to incorporate any earthy material with this ſort of manure, the agricultor ſhould always carefully attend to the ſtate or richneſs in which it may exiſt in the yard, and proportion ſuch additions accordingly. It will, however, never demand nearly ſo large a proportion, as ſuch manures as conſiſt almoſt wholly of animal matters.

Where animal matters are collected and thrown together in any quantity, there can be little doubt but that a great increaſe of good manure may be provided by mixing with them, as has been already obſerved, rich ſurface-mould, peat-earth, or the ſcrapings of old ditches and roads; as by ſuch a practice the ammonia formed during the decompoſition of the animal ſubſtances is prevented from eſcaping, as would otherwiſe be the caſe, which, by combining with and acting upon the earthy materials, quickly renders them proper for the purpoſes of manure. As ſubſtances of the animal kind have been ſhewn to run very rapidly into the ſtate of putrefaction, they may frequently be incorporated with ſuch vegetable materials as are little diſpoſed, or with difficulty made, to rot or become putrid, and by ſuch means uſeful compoſts be more expeditiouſly formed. In making uſe of ſuch earthy ſubſtances as have been mentioned, it may be of much advantage to have them expoſed to the influence of the atmoſphere for a conſiderable length of time, frequently turning them over, before they are mixed with the

manures, as by ſuch means they become in a more pulverized ſtate, and are capable of being more intimately blended with ſuch materials, and afterwards ſpread over the land with much greater equality, a circumſtance upon which their effects very much depend. If, in performing this buſineſs, the earthy ſubſtances be formed into a ſort of ridge, about five or ſix feet in height, and nearly the ſame breadth in the bottom, they will be in the moſt proper ſituation for being united with dung, or other matters that may be employed.

From the experiments of a late practical writer it would ſeem, that ſuch earthy materials as have been mentioned may be made uſe of to a very conſiderable extent, eſpecially where the manure to be mixed with them is of the animal kind *.

Lime is a ſubſtance that has often been too indiſcriminately made uſe of in the formation of compoſts, but which, by attending to the following circumſtances, may admit of being employed extenſively and with more beneficial effects. Where the deſtruction or decay of green or freſh vegetable matters, eſpecially thoſe of the more coarſe and hard kinds, is intended, it ſhould be uſed in its cauſtic ſtate in ſmall quantities; as in this condition, thus ſparingly employed, it reduces more expeditiouſly the ligneous and more hard parts of ſuch matters to an earthy ſtate; and as, during its action in this way on theſe ſubſtances, ſuch elaſtic matters are ſet at liberty, as by their ſubſequent combination afford ammonia or volatile alkali, it may frequently be a beneficial practice to blend ſuch earthy ſubſtances as have been juſt mentioned with them, and thereby prevent the elaſtic matters from being diſſipated and loſt. If a portion of rich farm-yard dung be afterwards incorporated with theſe materials, a valuable compoſt will be formed.

Quick-lime is likewiſe found uſeful ſometimes in bringing the hard parts of dead vegetable matters, as tanners' bark, fern, ſtraw, cabbage-ſtalks, leaves, &c. quickly into the ſtate of earth or mould; but whenever it is made uſe of in this way, it ſhould be had recourſe to only in a very ſcanty proportion to thoſe of the matters with which it is mixed, as when it is employed in large proportions it is liable, from the heat that is extricated or diſengaged by its combining with the moiſture of ſuch ſubſtance, being ſo augmented during its ſlaking, as to convert them into a coaly ſubſtance that is inſoluble, and at the ſame time to force off, in the form of gas, their elaſtic principles, except ſuch a quantity of carbonic acid as may combine with the lime during the proceſs.

* Experienced Farmer, vol. II. p. 55.

By the common practice of blending quick or cauſtic lime with farm-yard dung, much loſs is frequently ſuſtained; as by its violent operation upon ſuch ſubſtances, ſome of the elaſtic matters are not only ſet at liberty and quickly conveyed into the atmoſphere, but, with what remains, inſoluble ſaline compounds are formed which cannot aſſiſt vegetation*.

The complete putrefaction of ſuch manures, when neceſſary, is probably the beſt promoted by the uſe of lime in its mild ſtate, and the various means which have been already deſcribed.

When lime is to be blended with peat or earth, the moſt advantageous method is to uſe ſuch lime as has been newly made and well ſlaked, in the proportion of about one part of the lime to five or ſix parts of the peat or mould, which ſhould not be too much exſiccated, or dried, before it be made uſe of. By this means the heat which is generated will not be ſufficient to produce any injurious conſequences, either by forming a coaly matter, or forcing off the elaſtic principles in the ſtate of gas. And the volatile alkali which is compoſed in ſuch caſes, by being allowed to enter into combination, as it is formed, with that part of the peat or mould which has not been acted upon by the lime, in conſequence of its being employed in ſo ſmall a proportion, and in its effete ſtate, will form a ſoluble ſaline ſubſtance, capable of promoting vegetation †.

There are other ſubſtances that may be ſtill more beneficially employed in forming compoſts with peat earths, when they can be procured in ſuch quantities and at ſuch cheap rates as render them capable of being made uſe of in this way. Theſe are alkaline ſaline matters, or ſuch ſubſtances as contain them in any quantity; as by mixing theſe with the peaty materials in the way mentioned above, they are made perfectly ſoluble, while by the uſe of lime only ſuch a proportion of them is rendered ſoluble as can be acted upon by the quantity of ammonia or volatile alkali formed during the time it is mixed with them. And, farther, inſoluble compounds, ſuch as have been juſt noticed, are formed in the latter caſe.

It is common, in many diſtricts, to make compoſts with lime and mould on the head-lands, or other parts of the fields on which they are to be applied. This cannot however be done to any great advantage, except where the ſurface mould is rich in vegetable matter; but wherever ſuch compoſts are to be formed, the grounds

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 120.

† Ibid, p. 111.

ſhould be ploughed or dug up to a conſiderable depth, and reduced into as perfect a ſtate of pulverization as poſſible; freſh lime may then be placed, in ſmall heaps, all along the middle of the ridge or head-land, and the earth in this fine ſtate be thrown over them, in the proportion of four parts of earth to one of lime, and kept cloſe by being beaten down with the ſpade: from the gradual ſlaking of the lime, in this ſituation, by the moiſture of the earth, elaſtic matters are ſet at liberty, which combining with the mould or earth, render it ſtill further reduced, and by being afterwards very intimately blended by means of the ſpade with the very fine particles of the lime cauſed by the ſlaking, a valuable compoſt is made for the ſtiffer ſorts of ſoil, eſpecially if a ſmall quantity of good rotten dung be incorporated with them.

The animalized and other matters contained in farm-yard dung, or compoſt, from their being, in that ſtate, for the moſt part mixed and blended with large quantities of earthy materials, produced by the decaying or rotting of vegetable and other ſubſtances, and the depoſiting of ſoil or mould underneath them, as has been obſerved above, are ſeldom capable of admitting any further additions with advantage. But wherever there is much liquid matters oozing from ſuch compoſts, or ſtagnating about the bottoms of them, ſome of the earthy matters which have been mentioned ſhould be laid round them in order to abſorb or take them up, and prevent the great waſte that muſt otherwiſe take place, as may be often obſerved where dung compoſts are made in fields, the ſides of roads, or on other waſte grounds. This ſhould be more particularly attended to where ſuch compoſts are laid in ſituations that have not been properly formed as dung-ſteads; and, in ſuch caſes, it may frequently be an uſeful practice to place a conſiderable thickneſs of ſuch materials in the bottoms, before the farm-yard compoſt is carted out, and laid upon them, as by that means the manure heap may be greatly increaſed, at the ſame time that a proper ſubſtance for the volatile alkali contained in ſuch liquors to act upon, is ſupplied. The utility and advantages of this method of proceeding are fully confirmed by its becoming the prevailing practice wherever there is any attention paid to economy in the forming of compoſt manures.

There are many circumſtances, ſuch as the nature and ſtate or condition of the land, the goodneſs of the manures, the diſtance they are to be carried, and the expence of procuring them, which render a difference in the quantity of ſuch compound manures neceſſary, and which can only be properly judged of by the perſons who have the application of them: on the heavier kinds of land, ſuch as thoſe of a clayey or deep loamy nature, ſuch compoſts as are conſtituted of the lighter ſorts of earthy materials, ſhould always be employed; while on the

thinner and more light ſorts of ſoil, thoſe which are formed of clayey, loamy, or the more tenacious earthy matters, will be found the moſt ſuitable. In general, the allowance of ſuch manures ſhould be from ſixteen to twenty loads to the ſtatute acre, each containing ſeventeen or eighteen hundred weight. On many occaſions, however, a much larger proportion may be required, and in others a leſs may anſwer the intentions of the farmer.

The mixture of dung, litter, and other materials, which is gradually collected and formed into heaps in the farm-yard, is, in general, when employed without having any other ſubſtances incorporated with it, laid on ſuch lands as are under preparation for wheat, turnip, or barley crops. It is likewiſe in ſome ſome places laid on for a pea crop, where wheat is intended to be the ſucceeding crop*.

The compoſts, or manures, collected from the ſtreets of large towns, are commonly formed of a great variety of ſubſtances, as the recrements of decayed vegetables, putrid animal matters, and aſhes; but from their abounding, for the moſt part, with ſubſtances of the latter kinds, they may, on the principles we have ſo often ſtated, be in many inſtances greatly increaſed by having rich ſurface mould, or peat earth, blended with them; and by ſuch a practice, where the manure heaps are in a condition to admit of it, the riſk of waſte, by the eſcape or diſſipation of their more fluid contents in the aërial or gaſſeous ſtate, may be effectually guarded againſt.

Such additions can, however, be only advantageouſly made, where the proportion of animalized materials in the manure is conſiderable; in other caſes it will be better to employ them in the ſtate in which they are formed and collected.

This ſort of manure is capable of being made uſe of with great benefit on moſt ſoils, and in preparation for different ſorts of grain crops, as well as thoſe of graſs. When applied in the proportion of fifteen or twenty tons to the acre, it generally produces great fertility; it ſhould, however, like all other manures, be laid on according to the particular circumſtances of the ſoils, and the nature of the crops for which it is employed.

The trials of practical agricultors fully ſhew, that the moſt advantageous compoſts are thoſe which are formed by the combination of earthy materials with animal matters. In this way ground bones and whale-blubber have been found highly uſeful; but the effects of the former are aſſerted to be the moſt powerful when applied on the moiſter ſorts of ſoil†.

* Modern Agriculture, vol. II. p. 249. † Experienced Farmer, vol. II. p. 47.

From the whole of what has been advanced above, it is therefore probable, that by proper attention to the mixing together of fuch fubftances as are adapted to act upon each other, and fuited to the ftate of the foil, manures may be increafed and rendered much more ferviceable in promoting the growth of crops, and augmenting the fertility of land, than they have hitherto generally been.

MEANS OF *AUGMENTING* AND *PRESERVING MANURES.*

On due attention being paid to the increafe of manures and the modes of preferving and managing them, in a great meafure depends the general fertility of farms, and the luxuriance or goodnefs of the crops that are grown upon them. It is therefore a matter of great intereft and importance for the farmer to fee that nothing is wafted or thrown away that can poffibly be converted to fuch a purpofe. That there are many fubftances that may be rendered ufeful in this way, which have hitherto been little regarded by the cultivators of land, there can be little doubt, when the daily wafte of animal, vegetable, and other matters, that takes place in every country, from their being carried away by rivers, or confumed by fires, is fully confidered.

Another great caufe of lofs in the production of manures is from the want of adopting or putting in practice fuch modes of management, in refpect to different fubftances, as are capable of rendering them fit for the purpofe of application, in the moft quick and expeditious manner; for it is obvious, that if by properly attending to fuch means the fame quantity of manure can be prepared in a fhort fpace of time, which under other circumftances muft have required a long one, much increafe of manure may be effected, and confequently great advantages be gained by the cultivators of the ground. What is neceffary to be done in order to facilitate and haften the decompofition and reduction of different materials into the proper ftates for being applied to the foil, we have already feen to be, in fome meafure, the free admiffion of atmofpheric air, a quantity of moifture fuited to the condition of the matters made ufe of, and a due degree of heat. And alfo by the proper blending of animal with vegetable fubftances, in the incipient ftages, and the addition of lime, according to circumftances, and in proportions fuited to the ftate and nature of the ingredients.

As the principal refource, on moft farms, for the production of manure, is the farm yard, it fhould be conftructed in fuch a manner as that every thing may with eafe and facility be converted to the purpofe. In general one dung-

ftead may be fufficient; but where the fize of the farm is large, two or more may be neceffary, as the putrefaction of fuch heaps proceeds with greater regularity and expedition, from the accefs of air and moifture being more free, when they are not made too large; and, befides, they can be more conveniently turned over or removed. The parts of the yard on which they are fituated fhould, while they are convenient for depofiting the dung, and other matters from the fheds and other offices, upon, be neither too much elevated, fo as to caufe the dung to become dry, or fo greatly depreffed as to favour the ftagnation of water upon it, and thereby deprive it of the properties moft effential to the promotion of vegetation. Before each of the dung-fteads a refervoir, or bafin, ought to be made, into which not only the drainings from all the different fheds and places where animals are fed or kept, may empty themfelves, but likewife the urine from the neceffaries, the fuds from the wafhhoufes, and the wafhings of the various utenfils employed in the family. Without thefe advantages in the conftruction of farm-yards, much lofs of manure muft daily occur from the liquid matters of fuch places continually running away, and being otherways wafted, as well as from their not being made ufe of to forward the converfion of other fubftances into the condition of manures.

Where thefe and fuch other fuitable accommodations as have been already defcribed are provided, the farmer will have little more to do than be careful in faving or providing fuch matters as are fuitable for the purpofe, and caufe them to be properly placed and removed, in order to have them fpeedily reduced into the ftate of manure, and the quantity of his dung heaps thereby greatly increafed *.

In this view various vegetable matters, fuch as hay, ftraw, fern, leaves, rufhes, coarfe graffes, flags, and many other aquatic plants, fhould be preferved and collected in as large quantities as poffible; by allowing nothing of the kind to be fold or carried from farms, except in fome particular inftances, as where they are fituated near large cities, or towns, where fuch articles can be advantageoufly difpofed of for the purpofe of feeding and littering horfes, or other animals, and at the fame time an equivalent in good manure be brought back to the farm; by mowing and raking together the wheat or other ftubbles, the fern from the commons, and leaves where they can be obtained, as in the vicinity of parks and other woodlands, and by cutting the coarfe graffes and aquatic vegetables at fuch periods as they are in the moft juicy and fucculent ftates. The

* See the Section on Farm Buildings and Offices.

whole, after being fufficiently dried, fhould be carried to the farm yards, and ftacked up in convenient fituations, either in or near them, for the purpofe of being made ufe of as litter.

Befides thefe means, there are others that equally demand attention; every leifure opportunity fhould be taken, before the commencement of the foddering feafon, to bring into the farm-yards fuch quantities of peat or boggy earth, rich furface mould, marle, dry mud from ponds or ditches, fcrapings of roads, loam, and other fubftances of the fame kind, as can be conveniently obtained.

Such materials as are neceffary being by thefe methods procured, the beft mode of proceeding feems to be that of covering the whole of the yards, where the cattle ftand and tread, and even the pig-fties, in fome cafes, with layers of thefe earthy matters, eight, ten, or more, inches thick, according to the number of cattle, and other circumftances; and alfo to depofit in the refervoirs before the dung-fteads, proper quantities of the fame fubftances, for the liquid matters which come into them to act upon. Upon thefe earthy bottoms, at the time the cattle are confined, pretty thick litterings of one or more of the materials that have been collected and ftacked up, may be placed, and the ftables, cow and ox ftalls, pig-fties, &c. cleaned out upon them. Where it is the practice to tie up and confine the cattle in the night-time, the ftraw, or other fubftances, after having been broken down and reduced by littering them, may be ufed for covering the bottoms of the yards, by which means their decay may probably be rendered more quick and convenient. It appears alfo probable, that where ftubble, fern, rufhes, leaves, or other vegetable matters, the textures of which are hard and ligneous, are employed, their decay, or reduction into the ftate of manure, may be greatly expedited by means of a flight portion of lime, in its active ftate, being fpread over the earthy bottoms before they are applied, as has been found to be the cafe with tanners' bark.

Where the matters made ufe of in the way of manures are liable to be rendered too dry by the weather, their putrefaction and decay may be much promoted, as we have already feen, by having them fprinkled over occafionally with water, which may be conveniently and readily performed by having a pump, with troughs, fixed properly for the purpofe; or, where thefe are wanting, from a pond in the yard.

To render the plan the moft effectual it is capable of, the whole of the cattle fhould be ftrictly confined to the fold or foddering yards, during the winter, and not turned out, as is frequently the cafe, into the paftures, by which the making of much manure is prevented, great injury, in many fituations, done to the

grafs lands, and the ftock, from being much expofed to cold and other caufes, benefited in a far lefs degree than is commonly imagined. By purfuing this method, from the great confumption of ftraw and the coarfer forts of food, by the young lean cattle, and of hay and luxuriant vegetable roots or plants by the others, fuch quantities of animalized matters are voided, as by mixing with the bottoms of the yards haftens their putrefaction, and affords not only an immenfe increafe of manure, but of fuch as is of a very valuable kind. If there be not a fufficient proportion of animal dung and urine incorporated with the other matters, which can feldom be the cafe where the cattle are not regularly confined to the fold-yards, the manure, though it may be nearly as large in quantity, is found by experience to be very inferior in its effects when applied to land.

Where the number of cattle confined in the fold-yards is great, it may be neceffary, occafionally, to remove the bottoms, and the matters littered upon them, to the dung-fteads, after they have become in fome degree manures, by being well faturated and blended with the urine and other animalized matters. Thefe muft be immediately replaced by others in the way we have juft noticed.

The earthy fubftances from the refervoirs muft alfo be occafionally emptied out upon the dung heaps, and replaced by quantities of frefh materials of the fame kinds, and the ftems of different grofs vegetable products from gardens or other places when it can be done.

At the clofe of the feafon, when the cattle are turned out of the yards, the heaps of manure which have been thus collected and thrown together, are to be turned over, in order that the animalized matters may thereby not only be ftill more intimately incorporated with the earthy fubftances, but, likewife, that more of the pure air of the atmofphere may be retained among the clods, from their being rendered much fmaller by fuch means, and the putrefactive procefs be thereby more perfectly produced. After this bufinefs has been well performed, as little delay as poffible fhould be fuffered to take place before the manure is applied to the foil; as from the combination of oxygen or pure air with the carbonaceous material of the dung, and of azote with hydrogen, under thefe circumftances, fuch fluid matters are formed as conftitute its moft beneficial properties, but which are afterwards continually wafting fo long as it remains unapplied to the ground.

On thefe accounts, as well as thofe which have been already mentioned, manure heaps fhould not be made too large, but of fuch fizes only as that they can be expeditioufly turned over and put upon the land. And another advantage

which attends the having different heaps and their not being large, is, that one can be prepared and carted away at a time, without the other's being in the leaſt injured by any delay that may happen from unforeſeen cauſes.

By the mixing of lime with manures compoſed of earth, and dug, in the more advanced ſtages of their preparation, ſome increaſe of quantity may likewiſe be produced; and at the ſame time, as we have already ſeen, by its uniting with the nitrous acid during its formation, may prevent its being thrown off into the atmoſphere in a gaſſeous form, or readily waſhed down from the compoſts by rains; and thereby preſerve a ſubſtance that has long been found uſeful in promoting vegetation.

As a great waſte of manure is continually taking place from the evaporation of the more liquid parts of ſuch heaps, where they are much expoſed to the action of the ſun or winds, and the waſhings of the rains, it would no doubt tend greatly to the ſaving of ſuch matters, and at the ſame time conſiderably promote their complete putrefaction and decay, to have them placed in ſituations that are much ſhaded by trees or other means. In the farm yards, it is probable that moveable coverings of ſome light kind of material might be highly advantageous for the ſame purpoſes. By theſe means the manure heaps, in ſuch places, may be effectually ſcreened from the action of the ſun in the ſummer, and prevented from being injured by the heavy rains or ſnows that fall in the winter ſeaſon. The manures which have been preſerved from the effects of the weather in this way have alſo been found, by practical agricultors, to be far more efficacious in promoting the growth of crops, than under other circumſtances, conſequently capable of going much further*.

Different modes have been purſued, in different places, in order to procure manure from the articles of food and other matters produced on the farm; by ſome it has been ſtrenuouſly contended, that the moſt advantageous plan is to have the whole of the hay and ſtraw conſumed by the different animals, without employing any of them in the way of litter, floors or ſtandings for them being conſtructed in ſuch a manner, as that they can be tied up and kept clean and dry merely by ſweeping, without being littered with ſtraw or other ſimilar materials; while others aſſure us, on the ground of actual experience, that the method of eating the hay by the ſtock, and employing the whole of the ſtraw, as well as other matters, in the way of litter, as we have ſeen above, is by much

* Annals of Agriculture, vol. XXXIII. p. 593.

the moſt effectual in promoting the increaſe of manure. But though each of theſe methods may be practiſed, with more or leſs advantage, according to the nature of the farms ;—as where there is much graſs and little tillage land, the former may be preferable ; but where the quantity of graſs is ſmall, and that of arable ground large, the latter ;—it is probable, that a judicious combination of both may be the moſt beneficial, eſpecially where, in addition to the common articles, coarſe vegetable and rich earthy matters are provided and made uſe of in the way which has been mentioned, as by ſuch a combination the full effect can only be produced. In the former method, the loſs by means of digeſtion and animalization is probably much greater than has been generally ſuppoſed by thoſe who have maintained the ſuperior utility of the practice.

The ſoiling of horſes, and different kinds of cattle, with rich green food, as clover, ſummer-tares, and other artificial graſſes, cut freſh every day during the ſummer ſeaſon, and placed in cribs in the ſheds or foddering yards, the bottoms or floorings of which have been prepared and ſtrewed with earthy materials and litter, in the manner we have already ſeen, is a practice by which great additions may be made to the dung-hills, as the evacuations of cattle fed in this way are very conſiderable. It is remarked by the earl of Dundonald, that experience only can teach, or warrrant the belief of how few acres of ground, under the culture of artificial graſſes, when cut green, and daily given to working horſes and other cattle, will ſuffice for their maintenance. The artificial graſſes, or plants, beſt adapted to this purpoſe, are, he ſays, red clover, tares, and ſaint-foin. None of thoſe ſucculent plants with large ſtems and leaves anſwer, he obſerves, ſo well to be depaſtured as to be mown ; not only on account of the injury they receive in being bruiſed by the treading of cattle, but by being conſtantly cropped and kept ſhort, they are deprived of the nouriſhment which they principally receive by their ſtems and leaves. Saint-foin is, he thinks, beſt ſuited to chalky or dry ſoils, and to the ſouthern parts of Britain. It has often been tried without ſucceſs in the northern parts of England, and in Scotland. Winter tares have alſo been ſown, but have not been found to anſwer any valuable purpoſe. Clover and ſummer tares, therefore, ſhould, he thinks, be the only plants of which the cultivation on a large ſcale ſhould in theſe parts be attempted ; and every prudent farmer will take care to have a full ſupply of them, as in the event of a ſuperabundant quantity for green food, theſe crops are equally proper for hay. Tares ſhould always, he ſays, accompany the culture of clover, to ſupply the deficiency of herbage between the firſt and ſecond cuttings of the clover.

The quantity of manure that may be formed in this way is, probably, much greater than can be fuppofed by thofe who have not actually made a trial of the method: by fome French writers it is ftated, that from three or four hundred fheep, kept in this mode, manure fufficient for nearly an acre of land may be daily procured *; and the manures thus obtained are likewife afferted to be preferable to dung procured in the common method †.

Befides, the great wafte that unavoidably muft take place in feeding off fuch crops is prevented, and the whole of them immediately brought into ufe; and the manure thus produced becomes of a fuperior quality, from the vaft quantities of worms and other infects that are generated during the hot fummer months.

By means of covered fheep-folds, a great increafe might alfo be made annually to the ftock of manure. If this neglected, but highly beneficial, practice was regularly employed here, as is the cafe in many other countries, by having proper fheds and inclofures for the purpofe conftructed, of any flight materials, near to the fold-yards, or other more convenient places of the farm, fo that the fheep might have frefh air and fufficient liberty to run about, and at the fame time have the means of being fheltered from rain, fnow, and the coldnefs of the winter feafon, the advantages to the flock would likewife be confiderable, befides the great fupply of manure that muft be provided. In order to promote the latter advantage, the bottoms or floorings of fuch fheds and inclofures fhould be covered with fuch earthy materials as have been recommended for the cattle yards, and alfo littered upon in the fame manner; all of which ought to be removed and cleared away to a heap, or the common dung-fteads of the farm-yards, as often as they become perfectly faturated and blended with the dung and urine of the fheep, and frefh materials of the fame kinds fupplied. In bad weather it will be advantageous to keep them conftantly in thefe covered folds, and feed them with hay in ftanding racks; but when it is fine they may be fuffered to go into the paftures in the day-time, and only be put into the folds during the night.

The practice of keeping fheep in covered folds is made ufe of in Flanders for the purpofe of raifing manures with great fuccefs; and very dry fand is fometimes employed for the bottoms of the folds inftead of litter.

Where the houfe-lamb fyftem is carried on to any extent, the preparing and

* Laillevault. Recherches fur la Honille d'Engrais, tom. II. p. 69.

† Teffier Obf. fur plufieures Maladies des Beftiaux, p. 90.

littering of the fheds and yards, into which the ewes are occafionally put and the lambs kept and fuckled, might be practifed with great advantage in refpect to the production of manure, as animals under fuch kinds of management are conftantly found to void urine and dung in much larger quantities than in the ordinary courfes of feeding.

The ploughing down of rich green crops in their moft fucculent ftates, in the way that has been already defcribed, is alfo a means of increafing manure that may occafionally be adopted with advantage.

By feeding off different green crops on the land by fheep, bullocks, or other animals, much fertility may occafionally likewife be given to the foil, at a cheap rate, as the expence of carriage is prevented, and a confiderable faving of manure thereby effected. Mr. Middleton feems of opinion, that by this mode of management the great lofs of urine and dung that unavoidably occurs in the other methods may be the moft effectually prevented ; "For," fays he, "in the ftables, cow-houfes, fheds, fold-yards, and dung-hills, even under the beft management, there is a great wafte, perhaps of half, including dung and urine ; under ordinary management three parts of this manure is loft ; but in the foiling of tares, turnips, cole, clover, &c. in the fields, there is *no* lofs ; the whole is immediately applied, without the coft of carriage, to the enriching of the foil." It is evident, however, that in this way there muft be much more wafte than is here fuppofed : by evaporation, from the action of the fun and wind over fo extenfive a furface, much of the valuable matters of manure, in fuch fituations, muft be daily carried away ; and the more fibrous or ligneous parts of the materials, which are rejected as food by the cattle, from their being thinly fcattered over a large fpace, becoming dry and hard, muft be longer before they decay, or are rendered fit for the purpofes of manure, than where they are collected together in larger quantities and in more confined fituations.

Another means of increafing manures to a very great extent, is by adopting fuch methods as may effectually prevent the foil and urine of privies, and the various animal and vegetable materials that are continually thrown into them, in cities and large towns, from being ufelefsly retained in deep pits, or places conftructed for the purpofe, or inconfiderately wafhed away and wafted, by being conveyed into rivers or ponds by fewers and drains.

It is ftated, that, from want of fuitable modes of preferving fuch fubftances, the annual lofs, in this country, is probably not lefs than five millions of cart loads, which, if turned to the ufes of agriculture, would be worth to the cultivators

of the foil two millions and an half, and to the community five millions of pounds fterling * !

Befides this, the eagernefs which is manifefted in many other countries to preferve and promote the increafe of fuch manure, as in the Netherlands, Sweden, China, and Japan; according to the accounts of different travellers; fhews that it is a fubftance of great utility, and that a vaft fource of fertility is neglected.

The moft eafy and convenient methods of preferving fubftances of this kind in the country would be, probably, by having pits formed for the reception of them, as near as poffible to the dung-fteads in farm-yards or other places, and prepared with floors of clay, or fome other material through which the liquid matters could not readily pafs; thefe might be connected with the privies by proper drains, and have covers fitted to them, in order that a quantity of mould, peat earth, faw-duft, lime, ftems of coarfe garden plants, or other fubftances of the fame fort, might be occafionally placed in them, and removed to be blended with the common dung heaps, as often as they became fully reduced by putrefaction, and well faturated and impregnated. But in large towns or cities, where fuch manures are produced in great quantities, refervoirs or bafons of large fizes fhould be conftructed, with floors of the above kind, and be connected with the privies of different parts, by means of fewers or drains. Such refervoirs ought to be fo fituated as to be capable of being emptied with eafe and facility, as often as neceffary, by perfons appointed for the purpofe, and their contents carried away in the night-time. Where there is the convenience of rivers, however, as in London, and many other populous cities and towns, a large proportion of fuch manures might, in moft cafes, be readily emptied from bafons of this fort, formed on their banks for the purpofe, or perhaps from the extremities of the common fewers themfelves, by means of proper fluices, into covered boats or barges, and thus cheaply carried to a diftance, for the advantage of agriculture; a method, in fome refpects, practifed with fuccefs in Sweden †.

As this kind of manure is extremely liable, from the agitation of the carriage in which it is moved, to become fo liquid as to be conveyed with great difficulty, it is probable, that by having fuch earthy or other fubftances as have been mentioned above, or as could be conveniently procured in fuch large

* Middleton in Tranfactions of the Society of Arts, &c. vol. XVII.

† Communications to the Board of Agriculture, vol. I. p. 347.

cities or towns, fuch as the long littery dung from livery ftables, lime rubbifh from the pulling down of old houfes, and the frefh earth dug up in preparing the foundations for new ones, mixed and blended with it in the pits or refervoirs, for fome time before they are cleaned out, the difficulties attending the carriage of it might not only, in a great meafure, be obviated, but the difagreeable fmell iffuing from it be much corrected, and the quantity of manure greatly augmented.

By fome method of this nature, under the management and direction of proper perfons, vaft ftores of fertility might be provided in fuch places for the neighbouring diftricts, which inattention or popular prejudice at prefent withhold from the ufes of agriculture.

In the vicinity of the fea, where fhell and other fmall fifhes can frequently be procured in large quantities, by having them well mixed and incorporated with good furface-mould, peat-earth, or other fimilar matters, a vaft increafe of good manure may alfo be produced. In fuch fituations too, the weeds cut from the fides of the rocks, or which are thrown up by the tides, when collected into heaps, and mixed with fmall proportions of lime and fuitable quantities of mould or earth, may contribute greatly to the increafe of the compoft heaps on the farms.

It is obferved by an intelligent writer, in fpeaking of calcareous fubftances, that the recent fhells obtained from fifhing towns, operate much more powerfully as an animal manure than as a calcareous matter, when firft applied; and that it is not impoffible but that man may, in time, fall upon fome contrivance for obtaining this animal calcareous manure in much greater abundance and perfection than it has hitherto been obtained. " There is," fays he, " a fmall fpecies of frefh-water *wilk*, which increafes fo faft, as in a furprifingly fhort time to fill a confiderable fpace with folid wilks, if a few of them have been placed in a proper receptacle for that purpofe, and water duly adminiftered to them. If then ponds were prepared for this purpofe, and properly ftocked with this animal, and if they were allowed to increafe till a bed of them, of confiderable thicknefs, was accumulated, might they not then," fays he, " be taken out in abundance to be employed as a manure? Thefe, if bruifed under a ftone like a tanner's wheel, to reduce the fhell to fmall fragments, would certainly," he fays, " form as rich and efficacious a manure as could poffibly be devifed; nor could there be any difficulty in difpofing the ponds in fuch a manner as to afford a conftant annual fupply *."

* Anderfon's Effays, vol. I. p. 569.

The vegetable mould or other materials contained in the bottoms of ditches, and in boggy, hollow places, where water frequently ftagnates, and large crops of aquatic or other plants alternately vegetate and decay, may likewife be dug up and applied with benefit to foils for which they are proper, either in the ftate in which they are found, or after they have been formed into composts with dung, lime, or fome other fubftance of a fimilar kind.

Clay may alfo be employed with great advantage on fandy foils, and fave other more valuable manures; it feems, however, to be the moft ferviceable for this purpofe after it has been imperfectly burnt in clamps or kilns, probably from the proportion of oxygen or pure air that is thus combined with it, or with the metallic matters which it contains. In fhort, it is neceffary, in order to increafe the ftock of manures on farms to the greateft poffible extent, to be careful that none of fuch animal or vegetable fubftances as are capable of being converted into manure, be thrown away or confumed by fire, but that they be all conveyed to the dung-fteads in the farm-yards or other places, or laid in heaps of themfelves, and fuffered to pafs into fermentation, by which they may be fpeedily reduced to manure. Where the matter thus made ufe of chiefly confifts of weeds and the ftems or roots of coarfe plants, fuch as peas, beans, cabbages, docks, nettles, &c. their decay may be greatly promoted by a little quick-lime being blended with them. Such heaps fhould alfo be covered over pretty well with fome of thofe earthy matters that have been fo frequently mentioned.

As we have feen that the different materials which are made ufe of for the purpofe of manure, pafs through different ftages of decompofition and decay, in each of which fuch matters of the folid or fluid kinds are formed, as are capable of contributing to the nutrition and fupport of vegetable crops, but which are liable to be diffipated or carried away by the agency of various caufes, it may be neceffary to guard againft fuch wafte by keeping the dung-heaps covered, in every fituation, as much as poffible, with earth or foil, both in the early periods in which heat is evolved, and at the later ones, when ammonia or volatile alkali is formed; as by fuch management the proceffes of decompofition, when too rapid, may be reftrained, and the elaftic matters that are gradually fet at liberty be abforbed by thefe coverings, while the more fluid ones are detained by the earthy bottoms on which they had been placed, and thus the whole of the valuable properties of the manure be preferved.

GENERAL APPLICATION OF *MANURES.*

In the application of manure to land, ſeveral circumſtances are neceſſary to be conſidered, ſuch as the ſtate or condition of the ſubſtances which are to be made uſe of, the nature of the ſoils on which they are to be laid, the kind of crop that is to be promoted by them, and the ſeaſon in which they are put into or upon the ground.

As we have already ſeen that changes are continually taking place from the moment the materials of the dung-heap are thrown together, to the period in which they are reduced into a black carbonic earthy matter; and that in moſt of the different ſtages through which they paſs in this proceſs of decompoſition, ſuch ſubſtances are formed as are capable of contributing to the nutrition and ſupport of vegetable crops; it ſeems probable, that in caſes where manures are to be turned into the ground, and ſuch crops cultivated as require a ſupply of nouriſhment for a conſiderable length of time, they ſhould be employed in their long or more imperfeɛtly reduced ſtates, as by the heat which is evolved in the commencement of their diſſolution, the proceſs of early vegetation may be greatly promoted, and their gradual decompoſition and decay afterwards, under the ground, afford a more durable and regular ſupply of nutrient materials, and thereby contribute more effeɛtually to the growth of the crops; but that where they are to be buried in, or applied to, the ſurface of the ſoil, and intended merely for the benefit and ſupport of ſuch crops as are of ſhort duration, or quickly arrive at their full growth, they may be more advantageouſly made uſe of after they have been more fully and completely reduced, as in this ſtate the manure is, in the caſe of graſs lands, not only capable of being ſpread out in a more regular and uniform manner, by which it becomes more evenly as well as more generally carried down to the roots of the plants by rains, but it is in the moſt ſuitable condition for allowing the young plants the means of ſpringing up with facility, and at the ſame time, whether uſed under or upon the ſoil, of affording the crops that abundant ſupply of nouriſhment which is neceſſary to their ſpeedy growth and great luxuriance, and by theſe means to contribute the moſt perfeɛtly to the promotion of their increaſe.

Beſides the above advantages of long, or imperfeɛtly, decayed manures, they have others that depend on the ſoil into which they are turned, and the nature of the crops that are ſown or planted with them. Where they are employed

in ſuch ſtiff, clayey, or loamy grounds, as have a great tendency to become dry and hard, and thereby incapable of admitting the tender fibrous roots of grains or other plants to ſpread or extend themſelves, and draw in more abundant ſupplies of nouriſhment, they may be uſeful by keeping the earth around them in a more open and porous ſtate, from the ſlowneſs of their decompoſition, and the gradual and continued manner in which the different elaſtic matters are ſet looſe and united with the ſoil. Hence, when barley, or ſuch kinds of grain as require a rather light and open ſtate of ſoil, and thoſe bulbous or knobby rooted plants, ſuch as potatoes, that require much room to ſhoot and extend themſelves, are cultivated on ſuch ſtiff ſoils, they are generally found to be the moſt productive where ſuch long or imperfectly reduced manures have been made uſe of in the preparation of the land.

And as in the ſlow and gradual decompoſition of the materials which are made uſe of for manures, when ſlightly depoſited beneath the ſoil, there is much leſs waſte of heat and thoſe elaſtic matters which contribute ſo greatly to the ſupport of vegetation, than where they are made to undergo the various proceſſes of diſſolution in large maſſes, as in dung heaps, they may probably ſometimes on that account be moſt advantageouſly employed in this ſtate.

On this principle too the ploughing down of freſh vegetable crops, in many caſes, in their moſt ſucculent ſtates, may be a more economical as well as more beneficial practice; eſpecially in ſuch light and dry kinds of ſoil as will more readily admit of their gradual putrefaction and decay, than to cut and take them off for the purpoſe of being by other means converted into manure. It ſeems likewiſe probable, on the ſame grounds, that for the production of crops of bulbous-rooted vegetables on the more ſtiff and tenacious ſoils, the matters made uſe of as manures may be employed with the greateſt advantage, when put into the earth before they have undergone any great degree of decay by means of putrefaction, as in this way there is no waſte, the whole being ultimately converted and applied, though more ſlowly, to the ſupport of the crops.

As to the ſeaſon in which manures may be put into the ſoil, or ſpread out upon its ſurface, with the greateſt benefit and advantage, though in practice it muſt, in ſome meaſure, depend on the ſtate of the land and the convenience of the farmer, it ſhould, in caſes where they are buried in the ground, be as nearly as poſſible to the periods in which the ſeeds or the roots, which they are deſigned to ſupport, are ſown or placed in the earth; and in the latter caſe, or where they are to be laid upon the ſurface of the land, it ought probably to

be juſt before the crops of graſs, or other vegetables, begin naturally to ſpring or ſhoot forth.

By the practice of depoſiting and blending the manure with the ſoil, nearly at the time the crops are put in, there is ſcarcely any waſte of the fertilizing properties of ſuch ſubſtances, which, as they gradually proceed in their decompoſition and decay under the ground, muſt otherwiſe be the caſe, the roots of the plants not being in the moſt proper ſtates for taking them up and converting them to their ſupport. Beſides, in the ſtiff, loamy, or clayey ſoils, they have a tendency, as has been remarked above, to produce a degree of lightneſs and friability that is ſuited to the early proceſs of vegetation. And it is obſerved by an able writer, that " the atmoſpheric air, which is buried along with the manure in the interſtices of the earth, and which for many weeks, or even months, renders the ſoil looſe and eaſily impreſſed by the foot on walking on it, gradually evolves, by its union with carbon, a genial heat, very friendly to vegetation in this climate, as well as the immediate production of much fluid carbonic acid, and probably of a fluid mixture of nitrogen with hydrogen, which are believed to ſupply much nutriment to plants *."

And by the application of ſuch manures as are employed in the way of top-dreſſings in the beginning of the ſpring, they are laid on in the moſt favourable period for affording their nutritious principles, and for their being drank up by the roots of plants, conſequently become uſeful at the time they are moſt wanted for the promotion of the crops, and the great waſte which muſt otherwiſe be cauſed, either by the exceſſive falls of rains and floods in the winter ſeaſon, waſhing down much of the valuable properties into the adjoining rivers and ditches, or the evaporation of their more volatile or elaſtic matters by means of the ſummer heats, is moſt effectually guarded againſt and prevented.

The practice common in ſome places of applying manure to graſs lands in the latter end of ſummer or beginning of autumn, after the firſt crop of hay has been taken from the ground and the after-graſs has begun to make ſhoots, is not by any means ſo favourable as that of early ſpring, as in the latter caſe the generation of thoſe materials that contribute to the ſupport of vegetation is greatly promoted by the conſtantly increaſing heat of the vernal and ſummer months; while in the former it is conſtantly checked and retarded by the increaſing coldneſs of the autumn and winter ſeaſons. Beſides, the manure, by being ſpread out upon the ſurface of the land, under ſuch circumſtances, muſt be the cauſe

* Darwin's Phytologia, p. 251.

of great lofs, by contaminating the after-grafs, and rendering it incapable of being eaten off by cattle or other kinds of live ftock.

Where, however, a fecond crop of hay is to be taken, it may fometimes be put on at fuch times with advantage to fuch crop, efpecially if the weather be not too hot, and the manure in a perfectly fine and reduced ftate.

Doctor Fenwick, in his very ingenious reflections on manures, has very well obferved, that it is fcarcely poffible to fuggeft a worfe mode of ufing manures on grafs lands, than that which is almoft univerfally practifed in the neighbourhood in which he refides; and it is the fame in many other parts of the country, as is evident from the reports that have been lately publifhed under the authority of the Board of Agriculture: "When a fevere froft has bound up the land in a ftate of impenetrable cohefion, the farmers," fays he, "wheel on their dung, perhaps even when fnow has covered it. While the froft lafts the land can derive no advantage from the manure, and when a thaw fupervenes it is evident that the wafh from the melting fnow, or from the rains which generally fall in fuch weather, muft deprive the mafs of every part that is foluble. The ground, in the mean time, retains the froft for many days, and is therefore incapable of abforbing the wet which falls upon its furface; and even when the influence of the milder air has reached it, it can imbibe but little, being in general previoufly filled with water, and the quantity which flows over it being too great for foil under any circumftances to drink up*."

In favour of this deftructive and wafteful practice, however much it may have been defended on the ground of the farmer's leifure or convenience, and the little injury done to the turf or fward of the land, the fame writer thinks there can be only one reafon alleged, which is, that manure, when fpread early in the winter, may protect the roots of graffes from the feverity of frofts. This too is probably a miftaken notion, as it is known to every one, that the common graffes are feldom injured by the fevereft frofts; and other kinds of graffes may probably not fuffer lefs injury from the application of manure at fuch a feafon, than from the feverity of frofts.

On all thefe accounts, therefore, farmers fhould contrive as much as poffible to apply the manures, intended as top-dreffings to grafs lands, as early in the fpring as it can be conveniently done, which may be eafily managed on thofe that are dry, and on fuch as are inclined to be wet and poachy, it may probably be greatly facilitated by having fmall light carts constructed for the purpofe, and placed on broad cylinders as wheels. We are fully convinced, from the trials

* Fenwick's Reflections on Manures, p. 23.—Newcaftle.

which we have made in applying manures to grafs lands at fuch periods, that the trouble of the farmer will not only be rewarded by much larger crops of hay, but alfo by a confiderable increafe in the quantity of the after-grafs; and, befides, his crops in both inftances will be more forward than in the ordinary methods of putting them on, either in the autumn or the winter months, which in many cafes is a circumftance of great importance.

In the application of manures to lands under tillage, as well as thofe in the ftate of grafs, there are a few other circumftances that require the attention of cultivators; fuch as the depth they may be depofited in the foil, the modes of putting them upon the ground, and the moft economical methods of employing them.

As we have already feen that the putrefaction and decay of animal and vegetable matters, whether above or beneath the ground, is greatly promoted by the free admiffion of air and a fuitable degree of moifture to them, it is evident that they fhould not be buried fo deep in the earth, as that they may be prevented from readily receiving the aid of fuch caufes in forwarding their decompofition; nor, as the procefs is known to be much retarded by the fubftances being rendered too dry, fhould they be placed fo near the furface, or be fo thinly covered, as to permit the action of the fun and winds, before the crops have rifen to fuch heights as to prevent it, from diffipating and carrying away their nutritious properties. The introduction of the manure to a middling depth, as three or four inches, would, therefore, on thefe accounts, as well as from its contributing more expeditioufly and more fully to the vegetation of the crops that may be put in with it, feem, in general, to be the moft advantageous practice; but on the lighter and more friable foils, it may be advifable to plough it into a greater depth than in fuch as are heavy and tenacious. In every cafe, however, whether the manure made ufe of be in a long or a more reduced ftate, it fhould be perfectly covered or ploughed into the earth. The practice of burying manures deep in the foil, has been defended by fome on the ground of its being the nature of elaftic matters to rife or force themfelves towards the furface; but when they are placed to a confiderable depth in the earth, as the procefs of decompofition is thereby ftopped, or fuffered to proceed in but a very flow and feeble manner, little or nothing efcapes for the fupport of vegetation, or it is furnifhed in fo very flow and fparing a way, as to be of fcarcely any fervice to the immediate crops. Thus in the cultivation of fuch crops as are placed in rows or drills, where the manure is put into a great depth and covered pretty thickly with earth, on digging them up at the end of many months it may frequently be obferved nearly in the fame ftate it was when firft put into the ground. And the fame thing is often noticed by gardeners, where imperfectly reduced or long

dung is placed in deep trenches and covered to a confiderable thicknefs with mould.

In order that manures may produce their effects in the moft perfect manner, they fhould be fpread over the furfaces of the grounds as evenly as poffible, whether they be intended to be turned into the foil or left upon its furface as top-dreffings. This may be greatly facilitated by placing the manures out at firft in very fmall heaps, as by fuch a practice it may be fpread over the ground with much greater eafe and exactnefs; and on grafs lands much lefs injury will be done by the bottoms of the heaps.

On tillage lands, manures fhould always be turned in, or otherwife covered, as foon as poffible after they are fpread out; for if this be neglected, much lofs may be fuftained, efpecially in hot feafons, by the quick evaporation that takes place in fuch cafes. The beft practice is therefore not to carry more out from the dunghill at a time than can be conveniently fpread upon and ploughed into the earth in a fhort time afterwards. In fpreading manures employed as top-dreffings on grafs lands, much advantage will be gained by breaking and reducing the clods or lumps into as fine a ftate as poffible, as by fuch means they are not only applied more perfectly, but wafhed by the rains much more readily to the roots of the graffes. The fpringing of the young graffes is alfo lefs retarded where the manures are rendered fine and powdery, than where they are left in a cloddy ftate.

In the ufe of manures, it feems not improbable but that fome degree of faving may occafionally be made, as has been already recommended, by applying them on lands under tillage, as well as others, nearly at the time the feeds and roots are put into the ground, or when the graffes begin to fhoot; as from the whole of the manure being in this way made to contribute directly to the fupport of the crops, a lefs quantity may be fufficient for the purpofe: how far they may be fafely diminifhed on this principle, can only be fhewn by actual experiments and accurate deductions made from them; but there are fufficient grounds, from what has been obferved, for fuppofing that it may be confiderably more than can be eafily apprehended by thofe who have not adverted much to this circumftance.

Another economical mode of employing manure is, by placing it in the drills or hollows formed for the reception of different crops which are cultivated in rows, as peas, beans, cabbages, potatoes, &c.: by this method, that part of the ground which is intended to bear the crop is only manured, the intervals or fpaces between the rows not receiving any, from which, where the bufinefs

of putting the manure into the drills is properly performed, a great ſaving muſt of courſe be made. According to the concluſions of a later writer, the ſaving of manure in this way is ſo great as to conſtitute one of the chief advantages of the drill ſyſtem of cultivation. His calculation is, that by "drills being made two feet aſunder, and each drill ſix inches wide at the bottom, there will be juſt one fourth part of the ground covered with manure; for as ſix inches, multiplied by four, gives two feet, which will be the diſtance from drill to drill, and as four multiplied by four makes ſixteen, it follows, that if the whole of the land had been covered with manure, ſixteen loads would have been required for what is as fully and beneficially performed by four, that is by one quarter of the quantity uſed by the old method of dreſſing, ſuppoſing it of the ſame thickneſs and quality *." Beſides, from the manure being in this method kept cloſely together, and the ſeeds or plants placed immediately upon it, they muſt, he ſuſpects, receive the advantage of the dreſſing in a more full and complete manner.

As it appears probable that in the decay of different materials in the ſoil, all the nutritious matters as they are formed immediately become uſeful for the purpoſe of vegetation, without any waſte being ſuſtained, as muſt always be more or leſs the caſe where they are depoſited together in heaps, it may be an economical practice, as has been already obſerved, in caſes where the crops to be benefited by them require a regular and laſting but not large ſupply of nouriſhment, or where the ground is required to be kept in an open and rather light ſtate, for a conſiderable length of time, to employ ſuch manures in their leſs decompoſed ſtates, as by the ploughing down of green ſucculent vegetable crops, and the turning in of long ſtrawy ſubſtances.

By adopting ſuch means, the more perfectly formed manures of the farm may be reſerved for ſuch crops of luxuriant vegetables as demand more ſpeedy and abundant ſupplies of nutrient matters.

In reſpect to the advantage of uſing one ſort of manure in preference to another, it may be obſerved, that as animal matters are found in general to undergo more ſpeedily the proceſs of putrefaction or decompoſition, than thoſe of the vegetable kind, and as in moſt inſtances they afford thoſe mucilaginous and elaſtic principles that contribute ſo largely to the ſupport of vegetable life in greater proportions; ſuch manures as are either wholly or in a great meaſure compoſed of them, muſt be the moſt beneficially employed, where quick and

* Experienced Farmer, vol. II.

abundant fupplies of nourifhment are required, as in the growth of all the more grofs and luxuriant crops, whether of grain, plants, or graffes; and that as thofe vegetable fubftances which contain faccharine, farinaceous, oily, faline, or mucilaginous principles in the largeft quantities are afcertained from experience to proceed the moft readily into the ftate of diffolution or decay, and confequently to afford more fully and more expeditioufly the nutrient food of new plants, where manures are principally formed from them, they fhould be preferred to fuch as have been made from the harder and more ligneous vegetable fubftances, that contain fuch properties in fcarcely any, or much fmaller degrees, for all the purpofes of agriculture.

And laftly, fuch fubftances as are found to contain thofe elementary materials, of which vegetables are principally conftituted in their more foluble or loofely combined ftates, as carbonaceous matter in the black earths or moulds, and oxygen, azote, and hydrogen, in burnt clay, raddle *, manganefe, and calamy, fubftances which have hitherto been little employed, as well as in water and air, fhould be made ufe of in preference to thofe which poffefs them in flight proportions or fcarcely at all.

The moft convenient and advantageous modes of applying particular kinds of manures have been fo fully confidered, in the preceding parts of the fection, that nothing further feems neceffary to be added here in refpect to them.

* Raddle, according to the information of Dr. Darwin, has lately been ufed with advantage on fome lands in the north of Staffordfhire. Phytologia, p. 223.

SECTION VIII.

Draining of Land.

MUCH WATER neceſſary to the healthy Growth of Plants—Highly injurious to, when retained in or upon, Soils in over Proportions—Hence the Neceſſity of removing it, by draining ſuch Lands previouſly to other Improvements—Circumſtances on which the ſucceſsful Performance of this Buſineſs depends—The different ſtratified Nature of the Ground to be attended to—Diſtinction of the Strata in different Caſes—In Elevations or Hills—In lower Grounds—Reaſon of their Irregularity in different Inſtances—Manner in which Water is formed and collected on elevated Situations and brought down to the lower ones—Different watery Appearances produced thereby, as Swamps, Moraſſes, oozing Springs, weeping Rocks, large Springs, Rivulets, &c.—Break out at different Diſtances, according to the Nature and Regularity of the Stratum on which the Water paſſes—On what the difference of Force depends in different Caſes—Nature of the impervious Strata on which the Water is conducted—Clayey and compact marly Strata chiefly the Kinds on which Water is conveyed—They extend to different Depths in different Caſes—The clayey generally the more ſuperficial—Nature of the intervening porous Materials, in different Caſes—Different Situations of Ground in reſpect to Wetneſs—Methods of removing it in different Caſes and Situations of Land—Circumſtances to which Attention ſhould be paid in this View—Cauſes from which Wetneſs as reſpecting Agriculture moſtly ariſes—General Methods of removing by intercepting the Water of Springs—Different Caſes of—By cutting of Drains—By perforating by Means of the Auger—Caſes where the common Method of cutting various deep Drains may be practiſed with Succeſs—Where perforating the thin impervious Strata to the open porous ones may be made Uſe of—Circumſtances that tend to ſhew the Preſence of Springs—Caſes in which Water may be intercepted by cutting into the Sides of elevated Grounds, and carried off by ſuitable Means at high Levels—Drainage of Lands lying below the Level of the Sea only to be effected by expenſive Machinery—Encircling them with large Ditches might be beneficial—Surface Wetneſs, from the retentive Nature of Soils and Peculiarity of Situation, removed by hollow ſuperficial Drains properly formed—In graſs Land—In arable Land.—PRACTICAL METHODS of proceeding in the Drainage of wet boggy Lands—Circumſtances on which it depends in different Caſes of—Manner of Levelling for—Different Directions of the Strata produce Differences in—Means of aſcertaining the principal Spring in cutting Drains in—Effects of cutting them improperly in—Cutting in Caſes of irregular Banks—Mode of draining in narrow confined Bogs, where the porous Stratum containing the Water unites at but little Depth below the retentive Material—In thoſe of a more extenſive Kind—In marſhy or hollow Lands adjoining Rivers—Modes of forming the Drains in theſe Caſes—Kinds of moſt uſeful in—Sorts of Materials employed in filling them—Nature of Bricks uſed in conſtructing them—What requiſite to be attended to in putting in the Earth afterwards—Signs of Stoppage of

—Mouth of Drains to be guarded—Circumſtances which ſhew the Drains to be effectual—Method of Drainage where the under Stratum is porous, different from that of thoſe juſt deſcribed—Drains to be made in the moſt depending Parts through the upper ſurface Soil to the retentive Stratum—Boring then neceſſary to let down the Water—Same Purpoſe effected by deep Pits or Wells—Drains in theſe Caſes to be made narrow and filled with Stones—Attention neceſſary in forming the Ridges when the Land is to be in Tillage—Nature of porous Stratum firſt to be aſcertained—Drainage of Hills or elevated Paſture-grounds, what neceſſary to be attended to in—Drains made according to the Poſition of the Strata—Trenches neceſſary to be formed high up in the wet Soil to intercept the Springs—Other Cuts lower down requiſite in ſome Caſes—Both Sides of Hills may often be drained by cutting into the drier—Houſes conveniently ſupplied with Water in ſuch Caſes—May ſometimes be raiſed to a great Height in—The Cuts or Bores not to be made too deep in theſe Caſes—Method of Drainage where the Soil is formed of alternate Beds of Clay and Sand—Reaſon why more generally expenſive in—Manner of cutting the Drains in---Means of aſcertaining the beſt Situation for---Modes of draining in ſeveral Varieties of, deſcribed---Reaſon why the Drains ſhould be cut in an horizontal Direction---Fewer Drains neceſſary in theſe Soils---Cauſe of explained---Mode of Drainage where the Soil is porous above and retentive below, or the contrary---Methods of forming the Drains in the different Caſes of---By the Spade—By the Plough---Modes of filling them in---Implements made uſe of in cutting them---Beſt Seaſon for making them---Size of in different Inſtances---Much effected in ſuch Caſes by proper Conſtruction of Ridge and Furrow Expence and Duration of in different Caſes---Method of Drainage in Mines, Quarries, Marle, and other Pits ---Circumſtances to be attended to in different Caſes---By cutting off the Springs---By letting the Water down into the porous Stratum below---Uſes to which Water may be converted in ſome Inſtances of this Kind---Obſervations on Draining in general.

ALTHOUGH it has been clearly ſhewn by the various experiments and obſervations that have been made on the nature of vegetation, that a large proportion of water is eſſentially neceſſary for the ſupport of the healthy growth of plants, and which will be ſtill further explained in ſpeaking of the application of it to graſs lands; it is evident that it may exiſt in ſuch over-quantities, or be ſo retained in or upon the ſoil, as to prove not only highly injurious to the growth of the crops, whether of grain or graſs, but likewiſe prejudicial to the health of thoſe who inhabit the diſtricts where it is ſuffered thus to become ſtagnant. It therefore becomes the buſineſs of the farmer, in ſuch caſes, to attempt the removal of thoſe prejudicial exceſſes of moiſture, before he commences any other operations for the purpoſe of improving ſuch lands; as without fully accompliſhing this object, in the firſt inſtance, all his future exertions will be of but little avail. This may, in moſt inſtances, be accompliſhed by means of draining, a practice the ſucceſsful execution of which, in a great meaſure, de-

pends on a proper knowledge of the ſtructure of the earth, and of the various ſtrata of which it is compoſed, as well as of their relative degrees of poroſity or capability of admitting or rejecting the paſſage of water through them, and likewiſe the modes in which water is formed and conducted from the high or hilly ſituations to the low or level grounds. In whatever way the hills or elevations that preſent themſelves on the ſurface of the globe were originally formed, it has been clearly ſhewn, by ſinking large pits, and digging into them, that they are moſtly compoſed of materials lying in a ſtratified order, and in oblique or ſlanting directions downwards; ſome of which ſtrata, from their nature and properties, are capable of admitting water to percolate or paſs through them, while others do not allow it any paſſage, but force it to run or filtrate along their ſurfaces without penetrating them in any degree, and in that way to conduct it to the more level grounds below, till it becomes obſtructed or dammed up by meeting with impervious materials of ſome kind or other, when it is readily forced up into the ſuper-incumbent layers where they happen to be open and porous, ſoon rendering them too wet for the purpoſes of agriculture: but where they are of a more tenacious and impenetrable quality, they only become gradually ſoftened by the ſtagnant water below them; by which the ſurface of the ground is, however, rendered equally moiſt and ſwampy, though ſomewhat more ſlowly, than in the former caſe. It may alſo be obſerved, that ſome of the ſtrata which conſtitute ſuch hilly or mountainous tracts are found to be continued with much greater regularity than others; thoſe which are placed neareſt to the ſurface at the inferior parts of ſuch hills, or elevations, being moſtly broken or interrupted before they reach the tops or higher parts of them, while thoſe which lie deeper, or below them at the bottom, ſhew themſelves in theſe elevated ſituations. Thus, that ſtratum which may lay the third or fourth, or ſtill deeper, at the commencement of the valley, may be the moſt ſuperficial, or form the uppermoſt layer, on the ſummits of hills or mountainous elevations. This arrangement or diſtribution of the different ſtrata may have been produced partly by the circumſtances attending the original elevation of ſuch mountainous regions, and partly from the materials of the original exterior ſtrata being diſſolved and carried down into the valleys by ſucceſſive rains, and other cauſes, and thus leaving ſuch as were immediately below them in an expoſed and ſuperficial ſtate in theſe elevated ſituations *.

* See Darwin's Phytologia, p. 258.

But in whatever way or from whatever caufes it may have happened, that thofe ftrata which are placed at confiderable depths at the bottoms of hills, and other more elevated regions, prefent themfelves and become fuperficial upon their fummits, it is evident that they frequently prove the means of rendering the grounds below wet and fwampy: for, from the night dews, and the general moifture of the atmofphere, being condenfed in much greater quantities in fuch elevated fituations; from their greater coldnefs, or other caufes, than in thofe level furfaces which are below *; the water thus formed, as well as that which falls in rain and finks through the fuperficial porous materials, readily infinuate themfelves, and thus paffes along between the firft and fecond, or ftill more inferior, ftrata which compofe the fides of fuch elevations, until their defcent is retarded or totally obftructed, as has been juft fhewn, by fome impenetrable fubftance, fuch as clay; it there becomes dammed up, and ultimately forced to filtrate flowly over it, or to rife to fome part of the furface, and conftitute, according to the particular circumftances of the cafe, different watery appearances in the grounds below; fuch as oozing fprings, bogs, fwamps or moraffes, weeping rocks from the water flowly iffuing in various places, or a large fpring or rivulet from the union of fmall currents beneath the ground. This is obvious from the fudden difappearance of moifture on fome parts of lands, while it ftagnates, or remains till removed by the effects of evaporation, on others; as well as from the force of fprings being ftronger in wet than dry weather, breaking out frequently after the land has been impregnated with much moifture in higher fituations, and as the feafon becomes drier ceafing to flow, except at the loweft outlets. The force of fprings, or proportion of water which they fend forth, depends likewife, in a great meafure, on the extent of the high ground on which the moifture is received and detained, furnifhing extenfive refervoirs or collections of water, by which they become more amply and regularly fupplied. On this account, what are termed bog-fprings, or fuch as rife in valleys and low grounds, are confider-

* It is obferved by Dr. Darwin, in the firft volume of his Botanic Garden, p. 485; additional note xxvi. that the loweft ftrata of the earth appear on the higheft hills; that fprings are formed from dews fliding between them; that mountains are colder than plains; 1. from their being infulated in the air; 2. from their enlarged furface; 3. from the rarity of the air it becomes a better conductor of heat; 4. by the air on mountains being mechanically rarefied as it afcends; 5. gravitation of the matter of heat; 6. the dafhing of clouds againft hills; of fogs againft trees; fprings ftronger in hot days with cold nights; ftreams iffue from fubterranean caverns; from beneath the fnow on the Alps.

ably ftronger and more regular in their difcharge, than fuch as burft forth on the more elevated fituations or the fides of eminences *.

The waters condenfed in the manner defcribed above on the tops of elevated regions, are fometimes found to defcend, for a very confiderable diftance, among the porous fubftances between the different conducting layers of clayey or other materials, before they break out or fhew themfelves in the grounds below; but it is more frequently the cafe to find them proceeding from the contiguous elevations into the low grounds that immediately furround them.

The nature and regularity of the ftratum of materials, on which the water proceeding from the fummits of hills has to filtrate and flide upon, muft confiderably influence its courfe, as well as the effects which it may produce on fuch lands as lie below and into which it muft pafs: as where it is of the clayey, ftiff marly, or impervious rocky kinds, and not interrupted or broken by any other kind of materials of a more porous quality, it may pafs on to a much greater diftance, than where the ftratum has been frequently broken and filled up with loofe porous materials, in which it will be detained, and of courfe rife up to the furface.

It is for the moft part on the clayey, ftiff clofe marly, and unfractured ftony ftrata, that water is conducted from the hills and more elevated grounds into the plains and valleys which are below them.

Thefe forts of ftrata extend to very different depths in different fituations and diftricts, as has been frequently noticed in the digging of pits, and the finking of deep wells, and other fubterraneous cavities. The clayey ftrata are, however, in general found to be more fuperficial than thofe of the compact, tenacious, marley kinds, or even thofe of a firm, uninterrupted, rocky nature, and feldom of fuch a great thicknefs; they have, neverthelefs, been obferved to vary greatly in this refpect, being met with in fome places of a confiderable thicknefs, while in others they fcarcely exceed a few inches.

The intervening porous fubftances or ftrata where clay prevails are found, for the moft part, to be of either a gravelly or loofe rocky nature. Stiff marly ftrata, which approach much to the quality of clay, though in fome inftances they may prefent themfelves near the furface, in general lie concealed at confiderable depths under the true clayey, and other layers of earthy or other materials: they have been difcovered of various thickneffes, from eight or ten feet

* See Johnfton's Account of Elkington's Mode of Draining Land, p. 15.

to confiderably more than a hundred *. The intervening materials, where ftrata of this nature are predominant, are moft commonly of the more fandy kinds, peffeffing various degrees of induration, fo as in fome cafes to become perfectly hard and rocky, but with frequent breaks or fiffures paffing through them. The loofe, friable, marly ftrata are capable of abforbing water, and of admitting it to filtrate and pafs through them.

It may be concluded from this view of the nature and arrangement of the various ftratified materials that conftitute the earth, and the manner in which water is formed on the more elevated and hilly fituations, and brought down from them, that the valleys and more level grounds below muft conftantly be liable to be overcharged with moifture, and, as has been already fhewn, to become in confequence of it fpouty, boggy, or of the nature of a morafs, accordingly as they may be circumftanced in refpect to their fituation, the nature of their foils, or the materials by which the water is obftructed and detained in or upon them.

Where lands have a fufficient degree of elevation to admit of any over-proportion of moifture readily paffing away, and where the foils of them are of fuch an uniform fandy or gravelly and uninterrupted texture, as to allow water to percolate and pafs through them with facility, they can be little inconvenienced by water coming upon or into them, as it muft of neceffity be quickly conveyed away into the adjacent rivers or fmall runlets in their vicinity.

But where grounds are in a great meafure flat, and without fuch degrees of elevation as may be fufficient to permit thofe over-proportions of moifture that may have come upon them from the higher and more elevated grounds, either in the way that has been fhewn above, or from the overflowing of rivers and fmaller ftreams of water that may pafs through or near them, and from the falling of heavy rains, to readily pafs away and be carried off; and where the foils of the lands are compofed or conftituted of fuch materials as are liable to admit and retain the exceffes of moifture that may in any of thefe ways come upon them; they muft be expofed to much injury and inconvenience from the retention and ftagnation of fuch quantities of water, and confequently require artificial means to drain and render them capable of affording good crops, whether of grain or grafs: and, laftly, lands of valleys and other low places, as well as, in fome cafes, the level tracts on the fides or borders of large rivers and of the fea, from the peculiarity of their fituations, and their being compofed in a great meafure of porous or fpongy materials, formed by the diffolution and de-

* See Darwin's Phytologia, p. 259.

cay of various coarſe vegetable and other matters, which are produced on them, or which have been gradually, for a vaſt length of time, waſhed down and brought into them from the hills and riſing grounds by rains and other cauſes, or depoſited by means of floods, ſo as to form different degrees of accumulation, according to the difference of ſituation or other circumſtances, muſt alſo frequently be ſubject to great injury and inconvenience from the imbibing and retaining the water that may be thus forced to flow up into or upon them, either through the different conducting ſtrata from the hills and mountainous elevations in the neighbourhood, or the porous materials of the ſoils; as in theſe ways they may, as we have already ſeen, be rendered ſwampy, and have bogs or moraſſes produced in them in proportion to the predominancy of the materials by which the water is abſorbed and dammed up, and the peculiarity of the ſituation of the lands in reſpect to the means of conveying it away.

On theſe grounds, beſides a knowledge of the nature and inclination of the various ſtrata that compoſe the interior parts of the earth, it is clear that, in order to properly perform the buſineſs of draining, attention ſhould not only be paid to the diſcrimination of the differences in regard to the ſituation of the lands, or what is commonly denominated drainage level, but alſo to the nature, diſtribution, and depth of the materials that conſtitute the ſoils or more ſuperficial parts of them, as upon each of theſe ſome variety in reſpect to the effects ariſing from water retained in them may depend.

But though there may be conſiderable diverſity in the effects which water produces in or upon lands from theſe different cauſes, wetneſs of land, ſo far as it reſpects agriculture, and is an object of draining, may generally depend on the two following cauſes: firſt, on the water which is formed and collected on or in the hills or higher grounds, in the manner which has been explained, filtrating and ſliding down among ſome of the different beds of porous materials that lie immediately upon the impervious ſtrata, forming ſprings below and flowing over the ſurface, or ſtagnating underneath it; ſecondly, on rain or other water becoming ſtagnant on the ſurface, from the retentive nature of the ſoil or ſurface materials, and the particular nature of the ſituation of the ground. The particular wetneſs which ſhews itſelf in different ſituations, in the forms of bogs, ſwamps, and moraſſes, for the moſt part proceeds from the firſt of theſe cauſes; but that ſuperficial wetneſs which takes place in the ſtiff, tenacious, clayey ſoils, with little inclination of ſurface, generally originates from the latter.

From the ideas which have been ſuggeſted reſpecting the nature and formation of the different ſtrata that compoſe the earth, and of the manner in which

water ſlides, filtrates, or paſſes down among or between them, and forms ſprings, which, according to circumſtances, render the grounds below boggy, ſwampy, or too wet for the purpoſes of agriculture, it is evident that the beſt and moſt certain, as well as the moſt expeditious, method of draining, in ſuch caſes, muſt be that of intercepting the deſcent of the water or ſpring, and thereby totally removing the cauſe of wetneſs. This may be done where the depth of the ſuperficial ſtrata, and conſequently of the ſpring, is not great, which may be previouſly known by the uſe of a draining auger, by making horizontal drains of conſiderable length acroſs the declivities of the hills, about where the low grounds of the valleys begin to form, and connecting theſe with others made for the purpoſe of conveying the water thus collected into the brooks or runlets that may be near. And as the ſtrata between which the water paſſes down to produce ſuch ſprings have, for the moſt part, nearly a ſimilarity of inclination with that of the ſurface of the hill or riſing ground, the auger holes of the drains ſhould not, as is the general practice, be made directly downwards, but perpendicularly to the ſurface of the elevation, as in this way the ſtratum on which the water paſſes down may be more readily dug to and the water drawn off*; or where the ſpring has naturally formed itſelf an outlet, it may frequently only be neceſſary to render it larger, and of more depth, which by affording the water a more free and open paſſage may evacuate and bring it off more quickly, or ſink it to a level ſo greatly below that of the ſurface of the ſoil, as to prevent it from flowing into or over it.

But where the ſprings, from the great thickneſs of the upper ſtratum, are confined at ſuch a depth beneath the ſurface as that they injure it, by rendering it conſtantly moiſt, or by imperceptibly oozing through it, but afford no marks of any particular outlets; and where a drain cannot be cut ſo deep as to come to them, either on account of the great difficulty of doing it or the expence that muſt attend it, or where the level of the outlet will not allow of its being cut to that depth; it will be neceſſary, after cutting ditches in the way that has been juſt explained, to perforate the ſoil beneath by means of a boring inſtrument conſiderably deeper, ſo as to reach the ſpring, and thus give free vent to the water collected below;—a method of practice which ſeems long ago to have been ingeniouſly ſuggeſted by Dr. Anderſon, and ſince more fully and more particularly applied by Mr. Elkington.

Where this can be effectually accompliſhed, ſuch a number of perforations

* See Darwin's Phytologia, p. 262.

ſhould be made as will allow the confined water to paſs readily into the drains, and be conveyed by the connecting ditches to the adjoining ſtreams of the neighbourhood: in theſe caſes the water coming freely into the drains ſeveral feet below the moiſt ſurface of the land, and being then conducted away, will not be forced up through the ſuperincumbent materials of the ſoil to the ſurface which is ſo much higher *.

As in caſes of this kind, where, after boring in this manner, the water breaks forth with conſiderable violence, it may ſometimes be apt to bring up with it ſuch quantities of ſand, or other ſubſtances, as may block up the holes and prevent the free exit of the water, it may be neceſſary to apply the auger frequently in order to remove it. A ſtriking inſtance of this kind is related in the Philoſophical Tranſactions, where, on the ſinking of a well four feet wide, and 236 feet deep, and then boring ſome feet deeper with a five-inch borer, ſo much ſand was forced up by the impetuoſity of the water that broke forth as to fill the well, and which on being cleared away by buckets in its liquid ſtate, ſuffered the water to flow over the ſurface in the quantity of forty-ſix gallons in a minute.

There may be ſtill other ſituations of lands, as where the uppermoſt ſtratum is ſo extremely thick as not to be eaſily penetrated, or where the ſprings, formed by the water paſſing from the higher grounds, may be confined beneath the third or fourth ſtrata of the materials that form the declivities of hills or elevated grounds, on account of ſo many of them becoming deficient on their tops, or more elevated parts, and by this means lie too deep to be penetrated to by the cutting of a ditch, or even by boring; and ſtill, from the water being obſtructed by the different materials forming the plains below, may be forced up to the ſurface, and produce different kinds of injurious wetneſs †.

In ſuch caſes, the common mode of cutting a great number of drains to the depth of five, ſix, or more feet, acroſs the wet moraſſy grounds, and afterwards covering them in ſuch a manner as that the water may ſuffer no interruption in paſſing away through them, may be practiſed with advantage, as much of the prejudicial exceſs of moiſture may by this means be collected and carried away, though not ſo completely as by fully cutting off the ſpring ‡.

As water is ſometimes found to be conveyed from the hills and high grounds at no great depth beneath the ſurface of the land upon thin layers of clay,

* See Johnſton's Account of Elkington's Mode of Draining Land, p. 17.

† See Darwin's Phytologia, p. 263.

‡ Ibid.

which have underneath them ſand, ſtone, or other porous or fiſſured ſtrata, to a conſiderable depth; by perforating theſe thin layers of clay in different places, the water which flows along them may frequently be let down into the open, porous materials that lie below them, and the ſurface land be thus completely drained*.

* The Author of Phytologia, after ſhewing that from the variety in the direction of the ſtrata of the earth ſprings in ſome eminences of ground are only to be met with on one ſide of the mountain, while in others they may be on all ſides of it, remarks, that in ſearching for them attention ſhould be given to the inclination of the ſtrata of that part of the country, which may be often ſeen in marl-pits, gravel-pits, or in hollow lanes. But they may, he thinks, in general, be found above any moiſt or moraſſy plain or valley, the moiſture of which ſhews that ſprings exiſt in the ſtrata on that ſide of the mountain; and that a ſecond obſervation for the ſame purpoſe may be made on miſty evenings, as thoſe parts of the grounds where the miſt commences are moiſter than thoſe in their vicinity on the ſame level, and in conſequence may, generally, if they are not hollow baſons, poſſeſs ſprings nearer the ſurface: for theſe moiſter parts of the ground, having evaporated more during the day, are become colder on their ſurfaces than the drier ground in their vicinity; and in miſty evenings, which are at the ſame time calm, the ſtationary air over theſe moiſt parts of the ground is alſo more loaded with the evaporated moiſture; and on both theſe accounts theſe moiſter ſituations are liable to ſhew a condenſation of aërial vapour ſooner than other places on the ſame level. And as mountains are colder in proportion to their height, as already explained, the evening miſt ſometimes commences ſooner on them than in the valleys; but is ſeen earlier in theſe ſituations over the moiſter places, if they are on the ſame level with the drier ones, exactly as on the plains or valleys; and may therefore indicate the exiſtence of ſprings, unleſs theſe moiſter places conſiſt of hollow baſons containing water, which if not attended to may, in all ſituations, deceive the obſerver. And that another obſervation for detecting ſprings may be made in rimy mornings; for as moiſt earth is a better conductor of heat than dry earth, the rime will ſooner melt on thoſe parts of the ſoil which are kept moiſt by ſprings under it than on other parts; as the common heat of the earth, which is 48 in this country, will ſooner be conducted upwards in moiſt places to diſſolve the rime on the ſurface. On this account, the rime is frequently ſeen on froſty mornings, when the heat of the air is not much above 32, to lie an hour longer on dry cakes of cow-dung, or on bridges, or planks of wood, than on the common moiſt ground; as the latter much better conducts the common heat of the earth to the incumbent rime, which is in contact with it. But as the heat of the common ſprings in this country is 48, where they exiſt, the rime is ſooner diſſolved, than on the ſtagnant moiſture of bogs or moraſſes. And as the ſprings about Buxton and Matlock, and at Bath and Briſtol, are ſo much warmer than common ſprings, it is highly probable, he ſays, that where theſe waters approach the ſurface of the ſoil, they muſt much ſooner diſſolve the rime on froſty mornings; which may probably be obſerved in ſituations much higher than their preſent apparent ſources; as they ſlide down between the interior ſtrata of thoſe hills, beneath the ſummit of which they are condenſed, from the ſteam of water boiling at great depths in the earth, which riſes up through thoſe perpendicular clefts of the rocks which were formed at their original elevation.

He likewiſe further remarks, that in the winter months the riſe of ſprings may be detected in moiſt ditches by the preſence of aquatic plants, as of water-creſs, water-parſnip, brook-lime; as in thoſe

In thofe fituations of land where moraffes and other kinds of wetneffes are formed in fuch low places and hollows as are confiderably below the beds of the neighbouring rivers, they may, probably, in many inftances, be effectually drained by arrefting the water as it paffes down into them from the higher grounds, by means of deep drains cut into the fides of fuch hills and rifing grounds, and after collecting it into them conveying it away by pipes, or other contrivances, at fuch high levels above the wet lands as may be neceffary: or where the water that produces the mifchief can by means of drains, cut in the wet ground itfelf, be fo collected as to be capable of being raifed by means of machinery, it may in that way be removed from the land.

The drainage of thofe extenfive tracts of land that in many diftricts lie fo greatly below the level of the fea, can only be effected by the public, and by means of locks erected for the purpofe of preventing the entrance of the tides, and by windmills and other expenfive kinds of machinery conftructed for the purpofe of raifing the ftagnant water.

It is well obferved by a philofophical author, that it might be a noble work, worthy of the attention of a government that wifhed to increafe the quantity of nutriment and confequent population and happinefs of the country, to employ proper engineers, with labourers, in fuch numbers as to environ with ditches every moraffy diftrict, of whatever extent, as lies below the level of the tides, as the fens of Lincolnfhire and Cambridgefhire. Such ditches, he further remarks, fhould be cut at the feet of the adjacent rifing grounds, or of eminences furrounded with fens, like iflands in a lake; fo as to intercept the wall-fprings and land-floods, and convey the water thus collected above the level of the morafs into the ocean.

The fuperficial wetnefs of lands, which arifes from the ftiff retentive nature of the materials, that conftitute the foils and the particular circumftances of their fituations, is to be removed, in moft cafes by means of hollow fuperficial drains, judicioufly formed, either by the fpade or plough, and filled up with fuitable materials where the lands are under the grafs fyftem, and by thefe means and the proper conftruction of ridges and furrows where they are in a ftate of arable cultivation.

Having thus explained the manner in which foils are rendered too wet for

ditches which become dry in the fummer thefe plants do not exift: and when thofe ditches with fprings in them are nearly dry, it may be difcovered which way the current has formerly defcended by the direction of the points of the leaves of the aquatic plants as certainly as by a level; an obfervation which he learnt from Mr. Brindley, the great canal-conductor of Staffordfhire.

the purpofes of agriculture, and fhewn the principles on which the over-proportions of moifture may, under different circumftances, be the moft effectually removed, we fhall proceed to the practical methods which are to be made ufe of in accomplifhing the bufinefs in each cafe.

Methods of draining boggy land.—In the drainage of wet or boggy grounds, arifing from fprings of water beneath them, a great variety of circumftances are neceffary to be kept in view. Lands of this defcription, or fuch as are of a marfhy and boggy nature, from the detention of water beneath the fpongy furface materials of which they are compofed, and its being abforbed and forced up into them, are conftantly kept in fuch ftates of wetnefs as are highly improper for the purpofe of producing advantageous crops of any kind. They are, therefore, on this account, as well as thofe of their occupying very extenfive tracts in many diftricts, and being, when properly reclaimed, of confiderable value, objects of great intereft and importance to the attentive agricultor. Wet grounds of thefe kinds, from the nature of their fituations, and the modes of draining them, are arranged by a late practical writer under three diftinct heads: firft, fuch as may be readily known by the fprings rifing out of the adjacent more elevated ground, in an exact or regular line along the higher fide of the wet furface; fecond, thofe in which the numerous fprings that fhew themfelves are not kept to any exact or regular line of direction along the higher or more elevated parts of the land, but break forth promifcuoufly throughout the whole furface, and particularly towards the inferior parts, conftituting fhaking quags in every direction that have an elaftic feel under the feet, on which the lighteft animals can fcarcely tread without danger, and which, for the moft part, fhew themfelves by the luxuriance and verdure of the grafs about them; third, that fort of wet land, from the oozing of fprings, which is neither of fuch great extent, nor in the nature of the foil fo *peaty* as the other two, and to which the term *bog* cannot be ftrictly applied, but which in refpect to the modes of draining is the fame *.

In order to direct the proper mode of cutting the drains or trenches in draining lands of this fort, it will be neceffary for the operator to make himfelf perfectly acquainted with the nature and difpofition of the ftrata compofing the higher grounds, and the connection which they have with that which is to be rendered dry. This may in general be accomplifhed by means of levelling and carefully attending to what has been already obferved refpecting the formation of hills and elevated grounds, and by infpecting the beds of rivers, the edges

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 19.

of banks that have been wrought through, and fuch pits and quarries as may have been dug near to the land *. Rufhes, alder-bufhes, and other coarfe aquatic

* It is remarked by Mr. Johnftone, in his interefting practical account of Mr. Elkington's mode of draining land, that after the principal fpring, or that from which the others are formed, has been fully determined, it is one of the firft and moft important parts of the bufinefs, to afcertain a line on the fame level on one or both fides of it. This is to be done by means of levelling, in which the inftrument called the *fpirit-level* may be thus employed. The implement being properly adjufted, and a ftaff of about ten feet in length, with a moveable vane or fight fixed upon the top of it, is to be fet up in a fituation between the object from whence the level is to be taken, and that to which it is to be directed, provided the diftance from the inftrument to each of them is not too great. The fituation of it fhould alfo be no higher than the length of the ftaff will anfwer, and fo as it may be feen from it both ways: then direct the man with the ftaff to hold it at the *main fpring*, or place from whence you mean to carry the drain; and after directing the telefcope to the ftaff, and adjufting it to a level, make a fign to him to move the fight up or down, till it be exactly oppofite the crofs hair in the telefcope. This done, without fhifting the inftrument from its firft pofition, and cautioning the man to fix the fight to the ftaff at the point directed, he may proceed forty or fifty yards further; and after having again adjufted the level, make a fign to him to move to *higher* or *lower* ground, till the fight on the ftaff coincide exactly with the crofs hair in the telefcope. He may then leave a peg at the place where he held the ftaff, and proceed, in like manner, to other ftations, till the whole line is finifhed, leaving pegs, or making pits, at the places where the ftaff was held. If the length of the line to be levelled requires the inftrument to be fhifted from its firft pofition, the level muft again be taken from the laft ftation where the ftaff was held, and the fight on it fixed in the proper place, as before directed, proceeding in the fame manner at every forty or fifty yards in length, till the whole is accomplifhed. After the line is thus levelled, and afcertained by marks left at every ftation where the ftaff was fixed, it may again be examined, and other pegs put in between the firft, the better to direct the workmen in cutting the drain, giving the line fuch turnings and even fmall deviations from the courfe of the level, as may fhorten or ftraighten it, and humour the fituation of the ground. For the fake of accuracy, where the work requires it, efpecially if the water is to be conveyed any confiderable diftance, or wanted to fupply a houfe, or for the purpofe of irrigation, the levels, it is obferved, may be proved by reverfing the former line of direction. The fpirit-level is alfo, it is remarked, neceffary for afcertaining how fuch fall can be obtained from the drain to the neareft outlet where the water can be difcharged, the fhorter that diftance being the better, provided fall enough can be had.

It is further ftated, that it is often neceffary to level a much longer diftance than the length of the drain may require to be cut; but when the level of the whole line is known, and the nature of the ground carefully examined, fhort drains can be cut on that line with openings (places not dug out) between, which will anfwer the purpofe equally as well as one the whole length; and the expence will be confiderably lefs, provided the length of the conductors for the water from each be lefs than that of the openings or places not cut: but if the whole line, with only one conductor, be fhorter than thefe, it is better to have all the water difcharged at one orifice. The level has frequently to be taken from a fpring or well, at a confiderable diftance from the ground to be drained.

There is, likewife, another kind of level, which, from its having been made ufe of in America, and defcribed by Dr. Edwards, is frequently known by the title of the *American level*, that is extremely ufeful in determining the levels of drains and water-courfes; the conftruction and mode of applying which

plants, may alſo, in ſome inſtances, ſerve as guides in this buſineſs, but they ſhould not be too implicitly depended on, as they may be cauſed by the ſtagnation of rain-water upon the ſurface, without any ſpring being preſent.

Where the impervious ſtratum, that lies immediately beneath the porous, has a ſlanting direction through a hill or riſing bank, the ſurface of the land below that level will, in general, be ſpongy, wet, and covered with ruſhes on every ſide; while the higher ſide of it will be found to deviate very ſlightly from a level in any part round it. In this caſe, which is not unfrequent, a ditch or drain, properly cut on one ſide of the hill or riſing ground, may remove the wetneſs from both, as ſhewn in the plan *.

But where the impervious ſtratum dips or declines more to one ſide of the

is thus ſtated by the author firſt mentioned: "It is," ſays he, "formed of two pieces of thin wood, of equal length, joined together at top, and connected below by a croſs bar. From the angle at top, a lead plummet is ſuſpended by a ſmall cord, which, when the inſtrument ſtands level on both legs, ſtrikes upon a mark in the centre of the connecting bar;" which may be better underſtood by conſulting the annexed plate.

The manner of uſing it is, he obſerves, ſimply this: "at the place, from whence the level is to be taken, drive a wooden peg into the ground, cloſe in to the top, upon which one of the legs of the frame may reſt; then bringing round the other leg till it touch the ground, there drive in a ſecond peg, and the ſpace betwixt them will be level. In proceeding forward, reſt the leg of the frame upon the top of the ſecond peg, turning round the other leg as before; and where it touches the ground again drive in another peg, and ſo on along the whole line to be levelled. Thus," he ſays, "with very little trouble, and with as much accuracy as with the fineſt ſpirit-level, will the courſe of the drain be eaſily aſcertained. But as it is neceſſary that the drain ſhould have as much declivity as to allow the water to run freely, it will be requiſite, in taking the level, to regulate the direction of the line accordingly: half an inch fall in the length of the frame will be ſufficient." For this purpoſe, it is obſerved, it will be expedient to have, beſides a number of wooden pegs, one iron pin with inches and halves marked regularly upon the ſides of it, from the top downwards. After having drove in the firſt wooden peg at the point from whence you mean to conduct the drain, and having reſted the one leg of the frame upon it, turn round the other till it be level with the firſt peg; there put in the iron pin, ſo that this leg of the frame may reſt on the top of it when level; then drive in a wooden peg ſo far, as that the top of it may be one half-inch lower than that of the iron pin. Place the leg of the frame again upon this ſecond peg, turn it round to a level, putting in the iron pin till the top of it be equal with the foot of the frame; then drive in another wooden peg cloſe by the ſide of it, till the top of the wooden one be half an inch lower than that of the iron pin. Proceed in this manner ſo far as you mean to carry the drain, which will have the ſame degree of declivity all the way along. A line thus ſet off is marked from A to D in the repreſentation. It is remarked, that when made on a ſmaller ſcale, it is uſeful in aſcertaining the proper deſcent along the bottom of the drain, while the workmen are laying it, but that when made for this purpoſe, the croſs-bar muſt be fixed to the bottom of the legs, as marked with dotted lines in the repreſentation.

* See Johnſtone on Draining Land, p. 85.

hill or elevation than the other, the water will be directed to the more depreffed fide of that ftratum; the effect of which will be, that one fide of fuch rifing ground will be wet and fpongy, while the other is quite free from wetnefs *.

In the practical management of draining land, it will be neceffary after this to determine which of the places at which water iffues forth on the furface, if there be more than one, is the real or principal fpring, and that from which the other outlets are fed, as upon this muft depend the direction of the ditch or drain, as by removing that the others muft of courfe be rendered dry. When on the declivity or flanting furface of the elevated ground from which the fprings break forth, they are obferved to burft out at different levels according to the difference of the wetnefs of the feafon, and where thofe that are the loweft down continue to run, while the higher ones are dry, it is, in general, a certain indication that the whole are connected, and proceed from the fame fource; and confequently that the line of the drain fhould be made along the level of the lowermoft one, which, if properly executed, muft keep all the others dry. But if, as has been the too frequent practice, the drain was made along the line of the higheft of the outlets or places where the water breaks forth, without being fufficiently deep to reach the level of thofe below, the overflowings of the fpring would merely be carried away, and the wetnefs proceeding from that caufe be removed; while the main fpring, ftill continuing to run, would render the land below the level of the bottom of the drain ftill prejudicioufly wet, from its difcharging itfelf lower down over the furface of the ground. Thus, fays the author mentioned above, it was the cuftom, until Mr. Elkington fhewed the abfurdity of the practice, for drainers to begin to cut their trenches whereever the higheft fprings fhewed themfelves between the *wet* and the *dry* ground, which not being of a depth fufficient to arreft and take away the whole of the water, others of a fimilar kind were under the neceffity of being formed, at different diftances, to the very bottom of the declivity, which being afterwards in a great meafure filled with loofe ftones, merely conveyed away portions of furface water, without touching the fpring, the great or principal caufe of the wetnefs.

The effects of drains formed in this manner he afferts to be, that of rendering the furface of the land in fome degree drier, fo long as they continue to run with freedom; but as they are liable foon to be obftructed and filled up, by fand or

* See Johnftone's Account of Draining Land, p. 23.

other materials, the water is often forced out in different places and directions, and thus renders the land equally wet, if not more so, than it was before.

In addition to this, it is likewise observed, in the work we have already quoted, that it is a more difficult task to drain the ground a second time in a proper method, from the natural appearance of the ground being so much changed, and the bursts of the old drains, as well as the greater difficulty of ascertaining the real situation of the springs.

It may sometimes happen, however, as where the highest are the strongest outlets, that they may be the main or leading springs; those which shew themselves lower down in the land being merely formed by the water of the main spring overflowing, and finding itself a passage from an opening, or the porous nature of the materials of the soil near to the surface, and from being obstructed somewhat further down in the ground by some impervious stratum. This circumstance must therefore, it is observed, be fully ascertained before the lines for the ditches or drains are marked out.

In cases where the bank or rising ground is formed in an irregular manner, and from the erect nature of the situation or the force of the water underneath has been pushed down, the ditches made for the purpose of draining such lands should, it is remarked, always be carried up to a much higher level in the side of the elevated ground than that in which the water or wetness appears, as to the firm unchanged land; by which means the water of the spring may be cut off, and the ground completely drained; which would not be the case if the trench or drain were formed on the line of the loose materials lower down where the water oozes out, which is liable to mislead the operator in forming the conducting trench, or that which is to convey the water from the cross-drain on the level of the spring to the outlet or opening by which it is discharged. But where the main or principal spring comes out of a perpendicular or very steep bank, at a great height above the level of the outlet into which it may discharge itself by means of a drain, it will neither be necessary nor of any utility to form a deep trench, or make a covered drain, all the way from such outlet up to it, as from the steepness of the descent the water would be liable, when the drain was thus cut, from the thin strata of sand, and other loose materials, always found in such cases, to insinuate itself under the bricks, stones, or other substances of which the drain was formed, to undermine and force them up by the strength of the current, or, probably, in some instances, block the drain up by the loose sand, or other matters, which may be forced away and carried down by it; in situations of this kind, Mr. Johnstone observes, it is always the best way

to begin juft fo far down the bank or declivity as, by cutting *in level*, the drain may be fix or feven feet below the level of the fpring, or fuch a depth as may be requifite to bring down the water to fuch a level as will be fuitable to convey it away without its rifing to the furface, and injuring the lands around it. The reft of the drain, whether it be made in a ftraight or oblique direction, need not be deep, and may, in many inftances, be left quite open ; it fhould, however, be carefully fecured from the treading of cattle; and, where the land is under an arable fyftem of cultivation, alfo from the plough. Where it is covered, the depth of about two feet may be fufficient. There will not, in fuch drains, be any neceffity for the ufe of the auger in any part of them.

Where there is a difficulty in afcertaining the line of the fpring, and confequently that of the crofs-drain, either from its not fhewing itfelf on the furface, or from there not being any apparent outlet, it may, generally, be met with in carrying up the conducting drain for conveying away the water, which as foon as the operator difcovers, he need not proceed any further, but form the crofs-drain, on the level thus difcovered, to fuch a diftance on each fide of the *tail*, or terminating part of the ftrata, of whatever fort, that contains the water, as the nature of the land, in regard to fituation or other circumftances, may demand. Where, in forming a crofs-drain, the line indicated by the fpirit or other level is found to be in fome places below that of the fpring, and where, in boring in this direction, water is not found to follow, it will be neceffary to make fhort drains or cuts of the fame depth with the crofs-drain from it quite up to the fource of the fpring; for if the drain be cut below the line of the fpring, the poffibility of reaching it by means of an auger is loft, as where the under ftratum is clay, and there is no under water, the ufe of the auger cannot be effectual ; and if it be made above the line of the fpring, it will be requifite to cut and bore much deeper, in order to reach it, the ground being, in general, higher in that part; befides the portion of porous ftratum, below the drain, may contain a fufficient quantity of water to render the land wet, and that may readily get down underneath the trench, between the holes formed by boring, and break out lower down. Thefe circumftances are rendered more clear in the plan*.

In fituations where the extent of bog in the valley between two banks or eminences is fo narrow, and limited, as that the ftratum of rock, fand, or other materials that contains the water, may unite below the clay at fuch a depth as to be readily reached by the auger, it will feldom be neceffary to have

* See Johnftone's Account of Draining Land, p. 27.

more than one trench up the middle, well perforated with holes by means of the auger; crofs or branching drains being unneceffary in fuch cafes. For notwithftanding the fprings, that render the land injurioufly wet in thefe cafes, burft out of the banks or eminences on every fide, for the moft part nearly on the fame level, the refervoir from which they proceed may be difcovered in the middle of the valley, by penetrating with the auger through the layer of clay, that confines and forces the water to rife up and ooze out round the fuperior edge of it, where it forms an union with the high porous ground. From the drain being made in the holloweft part of the land, and the porous ftratum containing the water being then bored into, it is obvious that the ditch or drain thus formed being fo much lower than the ordinary outlet of the fprings, the preffure of water above that level, which is the bottom of the drain, muft be fuch as to force that which is under the drain or trench through the holes made by the auger, and in many inftances, until a confiderable quantity of the water is evacuated, make it rife to a greater height than the level of its natural outlet. The effect of which muft be, that the water forming the fpring having found by thefe means a frefh and more eafy paffage, will quickly relinquifh its former openings, and thus be prevented from running over and injuring the ground, that previoufly laid lower down than it *.—This will be better underftood by the plate.

But in fwamps or bogs that are extenfive and very wet, other drains or cuts than fuch as convey off the fprings muft be made; as notwithftanding the higher fprings which chiefly caufe the wetnefs may be intercepted, there may be lower veins of fand, gravel, or other porous materials, from which the water muft likewife be drawn off. In cafes of this nature where the land is to be divided into enclofures, the ditches may be formed in fuch directions as to pafs through and carry off collections of water of this kind, as well as thofe that may be retained in the hollows and depreffions on the furface of the land †. It is alfo further remarked in the practical work juft mentioned, that there are in many places very extenfive tracts of ground that are rendered wet, and become full of rufhes and other coarfe plants, from caufes of fuch a nature as cannot be obviated, by the making of either open or covered drains, however numerous they may be. Lands in this fituation are frequently termed holms, and moftly lie on the fides of fuch rivers and brooks as, from the frequency of their changing and altering their courfes between their oppofite banks, leave depofitions of fand, gravel, and other porous materials, by which land is formed, that readily admits

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 28. † Ibid. 29.

the water to filtrate and pafs through it to the level of the laft-formed channels, and which preferves it conftantly in fuch a ftate of moifture and wetnefs, as to render it productive of nothing but rufhes and other aquatic plants; and if a pit or ditch be made in lands under thefe circumftances, it quickly fills with water to the fame level as that in the water-courfe. This effect is, however, more liable to be produced, as well as more complete, where the current of the water is flow, and its furface nearly equal with that of the land, than where its defcent is rapid. Under fuch circumftances, while the river or brook remains at the ordinary height, no advantage can be gained, whatever number of drains be formed, or in whatever direction they may be made. The chief or only means of removing the wetnefs of land proceeding from this caufe is, that of enlarging and finking the bed of the ftream, where it can be effected at a reafonable expence: where there is only one ftream, and it is very winding, or ferpentine in its courfe, much may however be effected by cutting through the different points of land, and rendering the courfe more ftraight, and thereby lefs liable to obftruct the paffage of the water. But in cafes where there are more than one, that fhould always be made the channel of conveyance for draining the neighbouring land, which is the loweft in refpect to fituation, and the moft open and ftraight in its courfe. It may likewife, in particular inftances, be advantageous to ftop up and divert the waters of the others into fuch main channels, as by fuch means alone they may often be rendered deeper, and more free from obftruction *: the materials removed from them may ferve to embank and raife up the fides to a greater height, as while the water can rife higher than the outlets of the drains, and flow backwards into them, it muft render the land as wet as it was before they were formed, and the expence of cutting them be thrown away.

In addition to the injury done by the water from the rivers in fome fituations, fprings, it is obferved, break out from the bottom of the more elevated banks, and are abforbed fo as to filtrate through the materials of the foil above their levels. The wetnefs proceeding from thefe, may be readily intercepted, or reduced to the level of the ftream, by means of a drain. There are inftances too, it is faid, in which the wetnefs arifes entirely from fprings; as where the foil of the flat land between them and the river is not formed of loofe fand, or gravel, but of loam, or a mixture of clay and loam. In fuch inftances as thefe, the water proceeding from the fprings is interrupted, and prevented from filtrating through the materials of the foil in its paffage to the river, and thus forced up to the furface, over

* See Annals of Agriculture, vol. XXXVI. p. 88.

which it runs. In order to drain land in this ſituation, it is recommended that a trench ſhould be commenced at the lower end of it, and brought from the river on the bottom of the bank whence the ſpring breaks forth. It ought likewiſe to be cut *below* the line of the ſprings, where it can be accompliſhed with greater facility, and kept open, in order to take the river water in time of floods, which would blow or break it up if it were covered, and likewiſe ſuch runs of water from the more elevated grounds as may be produced by rains. Short covered drains muſt alſo be formed from this trench, a little diſtance into the bank, the bottoms of which ſhould be higher than the level of that of the open one, in order to prevent any of the water contained in it from running back into them. Where the depth of this level does not reach the ſtratum that contains the water, in ſuch caſes the auger may alſo be employed to tap or let off the water of the ſprings. Croſs-drains, between the open cut and the river, will not here be neceſſary, as the whole of the intercepted water will be conveyed along the bottom of the bank, and be diſcharged at a lower level into the river, except when the land is ſo extenſive as to admit of being divided by croſs-ditches into diſtinct incloſures. In theſe caſes the open drain, on the upper ſide, may ſerve as a diviſion between the meadow and the high grounds *.

After being drained, land of this deſcription is particularly well ſituated for watering, and the ſoil capable of being greatly improved by it, when proper modes are adopted.

Some attention is required, in the drainage of ſuch lands, to the method of forming the drains, and the neceſſity of their being open or covered. Where the land is to be incloſed at the ſame time that it is drained, as the line of the trench may, in moſt caſes, ſerve as a ſuitable diviſion of it, there can be no doubt but that an open drain will be the moſt proper; but where there is not a neceſſity for incloſing the land, a covered one may be preferable. Theſe points ſhould in the firſt place be determined upon, and the depth, width, and other circumſtances of the drain be regulated by them.

When the outlet, by which the water accumulated in the drain may be conveyed away, has been fixed upon, which ſhould generally be the neareſt and moſt convenient, a trench is directed to be brought up from it to the croſs-drain that is to be formed all along on the line of the ſpring; an inclination of a few inches in every eight or ten yards being given for the purpoſe of permitting the water to paſs away. When in cutting the drain that is to take off the ſpring,

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 30.

after getting through the clay, there happens to be a layer of firm gravel between it and the porous ſand or other material that contains the water, the drain ſhould be laid upon it, as being more ſolid; and to perforate the gravel with a punch, or dig ſmall pits in it by the ſpade, in order that the water may riſe up and paſs off with eaſe and ſafety, in preference to that of the ſand below; by laying it upon which, the depth and difficulty of conſtructing it would not only be greatly increaſed, but in different inſtances be incapable of being performed, from the level of the orifice not permitting its being cut to ſuch a depth. In cutting the drain or trench on the tail of a rock likewiſe, where ſuch kind of ſtratum exiſts, if the level of the orifice will not allow of its being made ſo deep as to reach the rock, the clay or other impervious ſtratum that may lie immediately above muſt be bored through, that the water may flow up through the fiſſures or cracks in the ſtone, and likewiſe the auger holes, into the drain or paſſage; but where the level will permit of it, it is obſerved, to be always more adviſable to cut the drain through the clay, and ſo far into the rock below as may be ſufficient for ſupplying the neceſſary quantity of ſtones for conſtructing the drain or ſough, as by means of the ſtone being thus broken, the water will have a more free and eaſy exit. The expence of cutting the drain may by this be ſomewhat increaſed; but probably, from its rendering the quarrying of ſtones in other places, and the carriage of them, unneceſſary, will, in moſt inſtances, more than compenſate ſuch additions of expence *.

Though, in the land to be drained, there may be an old ditch or water-courſe in which it may be poſſible to tap or let off the ſpring by means of the auger, it may, it is remarked, notwithſtanding, in moſt caſes, be preferable to make a new trench or drain, in which the water of the ſpring only may be conveyed; and in ſituations where it is under the neceſſity of croſſing ſuch old ditches or channels for water, it muſt be well ſecured by means of *puddling* with clay, ſo as not to admit any ſurface water, which, from its ſudden augmentation in caſe of floods, might quickly blow up, or break and deſtroy, the ſough or drain †.

As the water procured by tapping the ſprings in this way, may frequently be made to ſerve different uſeful purpoſes, ſuch as the irrigation of land, the turning of ſmall mills, the ſupplying of houſes, the filling of canals and ponds, in paſtures for the uſe of cattle, &c. the practice ſhould be adopted with great care, in order to guard againſt the loſs of water in one part of the drain by the ſame means that it may have been found in another, or by attempting to produce a

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 32. † Ibid.

larger fupply. As by fuch means it may, in many cafes, be let down from the wet retentive ftratum on which it refts into the dry porous one below, and thus be completely loft.

When the drain is made through a foft boggy foil, and where it may have other water than that which rifes from below paffing into it, it will, it is faid, be more proper to be open than clofed, as the ftones ufed in fuch drains are, from the foftnefs of the foundation, foon found to give way and fink down, and the fough or drain liable to be filled up and deftroyed. When the drain is covered, it is recommended to be made from three to four feet in width at the top, and from one and a half to two feet at the bottom, leaving in this way fix or nine inches for each fide ftone, the fame for the height, and fix inches between for the conveyance of the water, conftituting a fquare paffage or fough *. The level of the fituation where the drain is to difcharge itfelf, and the nature of the land through which it is to be made, muft regulate the depth. The turf is then to be pared off thin and laid on one fide, in order to be made ufe of afterwards; and the whole of the mould that may be dug up, thrown out on the other. The moft difficult part of the bufinefs confifts in laying the fough when in running fands †, it being frequently requifite under fuch circumftances to have the fides of the trench fupported, and the loofe fand prevented from falling down among the ftones employed in conftructing the drain, by means of flat boards and props, removed forwards as the work proceeds. When the fough or paffage is laid with brick, fmall apertures fhould be left betwixt each, to allow the water to pafs away from the fides of the drain, and the thin turfs are then recommended to be placed over immediately upon the ftones, without the intervention of any fmall, loofe ftones, the grafs fide downwards to keep the mould from efcaping through the crevices. This is neceffary, as the water principally proceeds from the bottom of the drain, but very little from the fides, and not the leaft from the top ‡.

Turfs are alfo advifed to be placed in the foundation of the drain underneath the trough in fuch quick loofe fands, to prevent them from flowing up, and to render the bricks more fecure in cafe of their giving way. In fands of this kind it is likewife a good way to dig juft into the fides of the trench, from the line of the fough, where the auger is to be employed, and when this has been done to cover the places in the fame way as the fough; as by this means the fand thrown up by the fpring may be readily removed, till fuch times as the

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 33. † Quick-fands.
‡ Ibid.

force of the ſpring abates, and it is free from the main current paſſing in the middle of the drain.

The portion of ſough above the holes, made by the auger, is recommended to be left open, till ſuch times as the ſand is brought up, and the openings are become perfectly free; but until this happens the ſand ſhould be conſtantly removed. Afterwards the ſough may be covered up with the greateſt ſafety. An opening, or kind of funnel, is likewiſe adviſed to be conſtructed above ſome of the holes formed by the auger, or at ſome other convenient part of the drain, up to the ſurface, for the purpoſe of occaſionally inſpecting it and ſeeing that it is open and clear, and whether the run of water increaſes or is diminiſhed. When the holes made by boring are not ſufficient for diſcharging or letting off the full quantity of water that the ſpring can emit, and when the ſtratum containing the water is near to the bottom of the trench, and there is a bed of hard gravel between, which cannot be eaſily penetrated by the boring inſtrument, holes or openings are recommended to be dug down to the ſpring by the ſpade, and afterwards filled up with ſmall, looſe ſtones, a round ſtake or piece of wood being previouſly put down in the middle and withdrawn when the ſtones have been filled in, in order that a good opening for the water to flow up may be provided*. If no other water but what comes from the drain be admitted, there will, it is obſerved, be no danger in ſuch caſes of the holes formed by the boring inſtrument being filled up, whether it be in an open or covered ſtate, as ſuch is moſtly the force of the water iſſuing through them that it can eaſily remove thoſe portions of earth or mud that may have been accidentally waſhed into it; the drains can therefore, of courſe, only be damaged by the flowing in of much ſurface or flood water upon a ſudden †.

In reſpect to the materials employed for the conſtruction of drains of this kind, ſtones are certainly the beſt where they can be procured at a ſufficiently reaſonable rate. Bricks may likewiſe be made uſe of where ſtones cannot be had, of which there are ſeveral different kinds invented for the purpoſe, beſides thoſe of the ordinary ſort:—as may be ſeen in the plate. Where ſmall drains are only wanted, as in conducting water for domeſtic uſes, a brick excavated in ſuch a manner as to form a kind of ſmall arch, may probably be made uſe of with moſt advantage. But in caſes where larger drains become neceſſary, a more ſolid kind which are formed for the purpoſe in different ſhapes, may be employed with greater ſucceſs. A ſort has lately been formed in Warwickſhire, that has been much employed in the conſtruction of ſuch drains. In making uſe of bricks of this deſcription, they

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 35. † Ibid.

are laid fingly, without having a reverfed one underneath; as when that is the cafe, it has been found, that the water paffing on the under one, is apt to produce a fort of earthy incruftation, which in the corufe of a few years becomes fo great as, in fome meafure, to block up the paffage of the water, and thus render the drain ufelefs. Where the foundation is of a clayey nature, they may always be fafely laid without having any thing underneath them; but where it is of a foft fandy kind, a common brick may be placed under each fide to retard their finking down, and fo placed as to form a regular arch that may refift the preffure from above. They are capable of being conftructed of the fame fhape to any fize, according to the dimenfions of the drain, or the quantity of water it may convey *.

Though the earth that has been dug out of the drain in thefe cafes, when filled into it again, may at firft appear confiderably higher than the common furface of the land on the fides, it fhould be let remain in that ftate, as in a little while it generally finks to the proper level; but when made exactly level at firft, from the earth's gradually finking down, hollows are formed that afford lodgments for water, which by finking through may injure the drains.

In very wet peat grounds, during the time the drain is forming, the water from the furface, or that which may trickle from the fides, before reaching the main body of water, fhould be ftopped occafionally; and when let off into the fough, a turf muft be placed fo as to prevent any foft earthy matter that may be forced down with it from paffing through, as injury may be done by it. If fuch trees as have fpreading roots happen to be in the line of the drain, they ought to be completely grubbed up; as, if this be not done, the fibres of the roots, by extending themfelves through the joints and crevices of the ftones, are apt to get into the drain, and quickly put a ftop to the paffage of the water in it †.

In cafes where the water iffuing from drains is tinged of a red ochry colour, it is a fign that there is a ftagnation proceeding from fome caufe or other, as that which has been juft mentioned, when the drain has been laid amongft trees, or from the breaking in of fome part of the fough, which fhould always be attended to, and removed or repaired as fpeedily as poffible, that the ground may not become again injured by wetnefs. In order to complete the bufinefs in all thefe cafes, the opening or mouth of the drain fhould be carefully guarded by fome means or other, fuch as a railing, from being poached, or forced in, and choked up by the treading of cattle in their attempts to drink at it; and where injuries have occurred in this way, they fhould always be fpeedily removed. The circumftances which firft afford evidence of the efficacy of the drain, and which

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 37. † Ibid.

ſpeedily become obvious when the ſpring or reſervoir of water has been properly drawn off, are, that all ſuch ſurface drains as may have been formerly made, and the neighbouring pits, ditches, and other hollow places to which the water may have been dammed up, become ſuddenly dry, and afterwards continue in that ſtate *.

There are large tracts of boggy waſte land, in different diſtricts of the kingdom, that cannot be brought into a ſtate of cultivation, from a wetneſs which does not originate from ſprings immediately beneath the ſurface, or the overflowings of any in the neighbouring high grounds, but from the collected rain water becoming ſtagnant on a retentive body of clay, or ſome other impervious material, through which the water cannot ſink; and being likewiſe encircled with higher ground compoſed of the ſame impervious ſubſtances, the water of itſelf can have no outlet of the natural kind; when ſuch lands become ſoft and ſpongy, they frequently form bogs of a very confined kind. And as ſuch bogs are often ſituated very greatly below the ground that ſurrounds them, the opening of a main drain, or conductor, to convey off the water collected by ſmaller drains, would be attended, in many inſtances, with an expence greater than could be compenſated by the land after it had been drained. The thickneſs of the impervious ſtratum that retains and keeps up the water in ſuch caſes, is often ſo great, that though the ſtratum below be of a porous and open nature, ſuch as ſand, rock, or gravel, the water cannot of itſelf penetrate or find a paſſage from the one into the other, conſequently, by its continued ſtagnation above, all the different coarſe vegetable productions that have for a great length of time been produced on its ſurface, and probably the upper part of the ſoil itſelf, are formed into a maſs or body of peat earth, equally ſoft and leſs productive than that of any bog originating from water confined below, and which is only capable of ſuſtaining the weight of cattle in very dry ſeaſons, when the wind and ſun have exhaled and dried up a great part of its ſurface moiſture, but even then it is incapable of admitting the plough upon it †.

As the cauſe of theſe kinds of bogs is materially different from that of thoſe which have been already noticed, their drainage muſt of courſe be accompliſhed in a different way. The following method of proceeding is recommended as perhaps the leaſt expenſive. In the middle, or moſt depending part, of the ground, the firſt drain may be cut, into which all the others ſhould be made to lead: the number and direction of which muſt be regulated by the extent of the bog. They ſhould be cut through the peat, or moiſt ſpongy upper ſoil, to the

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 38. † Ibid. p. 51.

ſurface of the clay, or other retentive ſtratum of materials, which muſt then be perforated or bored through in order to let the water down into the pervious ſtratum below, by which it may be abſorbed and taken up. The ſame effect might be produced by forming one large well, or pit, in the middle or loweſt part of the bog, by digging through into the porous ſtratum below, and connecting the other drains with it, as by ſuch a method the trouble and expence of boring along the drains would be ſaved.

In theſe caſes, when drains are made, they ſhould always be cut as narrow as it is poſſible to make them, and after the holes have been formed in them by boring, filled up with looſe ſtones to within about a foot and a half of the ſurface, which ſpace may be made up by a portion of the earth that had been taken out, putting a turf the green ſide to the ſtones before the earth is thrown in. By this means the water and prejudicial moiſture of the peat, or upper ſoil, may be taken away by the drains, and paſs off through the holes that have been formed in their bottoms. But where pits are employed, theſe ſhould only be filled with ſmall ſtones to the level of the bottom of the drain, the filling being performed as ſoon as poſſible after they are formed*: where there is a chalky ſtratum below, after taking it out, the flints contained in it may be made uſe of in this way, with much advantage; and where the drains can be carried into quarries, where the ſtone is much fiſſured, nothing more will be neceſſary†. Where land of this ſort is afterwards to be ploughed, great attention ſhould be given to the forming of the ridges, and giving them a regular deſcent towards the main drain, which will contribute greatly to the aſſiſtance of the others, in conveying off heavy falls of rain water when they occur.

But previous to any attempt to drain lands of this kind in the way that has been deſcribed, it is recommended as proper to aſcertain whether the porous ſtratum under the clay be dry, and capable of receiving the water when let down into it; or already ſo loaded with moiſture itſelf, as, inſtead of receiving more from above, it may force up a large quantity to the ſurface, and thus increaſe the evil it was intended to remove. This may be the caſe in many inſtances; and the ſubſtratum contain water which affords no appearances of wetneſs on the ſurface, at the place, on account of the compact body of clay that is placed over it, but which, from its being connected with ſome ſpring that is higher, may flow up, when an opening or paſſage is given it either by means of a pit or the auger. In this way a

* See Anderſon's Treatiſe on Draining, p. 88. † See Hertfordſhire Agricultural Report.

greater quantity of water might be brought to the furfaces, which, from its being confined by the furrounding banks, would render the ground much more wet than before, and in particular fituations produce very great degrees of wetnefs. When the furrounding high ground declines lower than the bog, though it may be at a confiderable diftance, by the aid of the level, and the appearance of the furface, the nature of the ftratum underneath may, it is obferved, in fome degree, be afcertained; and, notwithftanding it may already contain water, a drain may be formed into it to carry off that water, and what may likewife be let down into it from the retentive ftratum that lies above it;—as is feen by the plate.

Methods of draining hilly lands.—The draining of hills, and elevated pafture lands, have hitherto been but little attended to, though the herbage which is produced by the wetnefs of them from fuch inattention is, probably, the principal caufe of a difeafe extremely fatal to fome of the animals which they fupport.

Draining, in fituations of this kind, is not, in general, attended with great expence, as the drains need feldom be covered or filled up, only in fuch places as may be fufficient for paffages for the animals to crofs by. And though, where the depth of the trench does not come to the water confined below, it may be neceffary to perforate lower, there need not be any fear that the holes will fill up, even where the drain is left open, as the impetuofity of the water itfelf, as has been feen, will remove any fand or mud that may fall into them, where much flood or furface water does not get in: fmall openings may, however, be made along the upper fide of the trench, in order the more effectually to fecure them againft any obftructions; and in thefe the perforations may be made, leaving the mouth of the holes about fix inches higher than the bottom of the drain, which will be without the reach of the water that may be collected during the time of heavy rains. This may, however, be better underftood by the reprefentation in the plate*.

The fides or declivities of many hills, from the irregularity of the difpofition of the ftrata that compofe them, are often covered with alternate portions or patches of wet and dry ground. By the general appearance of the furface, and the vegetable products that are grown upon it, the nature and direction of the internal ftrata may, as has been already obferved, frequently be afcertained with fo much certainty, as to determine the line or direction of a drain, without the neceffity of examining below the furface of the land, as the eafe or difficulty of draining fuch grounds depends folely on the pofition of the different ftrata of which the hill or elevation may be formed, and upon the erect or flanting direc-

* See Johnftone's Account of Elkington's Mode of Draining Land.

tion of the rock, or other retentive body in which the water is contained; where the rock has a ſlanting or horizontal inclination, the whole of the different ſprings or outlets, that ſhew themſelves on the ſurface, may originate from or be connected with the ſame collection or body of water, and may be all drained and dried up by cutting off, or letting out, the main body of water, by which they are ſupplied, at the inferior part of the reſervoir, or that part where the water would of its own accord readily run off, if it were not confined beneath an impervious covering of clay, or ſome other material.

But in caſes where the rock lies in an erect or perpendicular form, and contains only partial collections of water, in ſome of the more open cracks or fiſſures of the ſtone, that diſcharge themſelves at various openings, or outlets, that have not the leaſt connection with each other; it would be an idle and fruitleſs endeavour to attempt the cutting of them off, by means of one drain, or by boring into any one of them in particular, without cutting a drain into each, as is ſhewn in the plate. In this caſe it is more adviſable to make the main drain wholly in the clay, with ſmall cuts made up to each outlet, than along the place where the ſprings burſt out; as in that line or direction it would be too greatly in the rock, and conſequently be extremely difficult to cut, on account of the nature and diſpoſition of the ſtone: when the water paſſing out on the line of the ſprings can be found by the auger in the main drain, at the point where it joins it, it will, it is obſerved, be the more completely cut off; but where this is not practicable, the depth of the ſmall cuts may reduce it to ſuch a level as will prevent its flowing over, and injuring the ſurface of the land below it *.

In ſuch hills as are conſtituted of alternate ſtrata of rock, ſand, and clay, the ſurface of the latter may frequently be wet and ſwampy, while that of the former is dry, and capable of producing good crops of graſs; in all ſuch caſes, in order to drain the land completely, as many cuts will be neceſſary as there may happen diviſions of wet and dry ſoil: the ſummit, or moſt elevated part of ſuch hills, being moſtly formed of looſe porous materials, through which the rain and other water deſcends, till its paſſage becomes obſtructed by ſome impervious bed or ſtratum, ſuch as clay, when it is forced up to the ſurface, and runs or oozes over the obſtructing ſtratum; and after having overflowed, the upper clay ſurface is immediately abſorbed and taken up by the ſucceeding porous one, and ſinking into it in the ſame way as before paſſes out again at the lower ſide of it, and renders the ſurface of the next clayey bed prejudicially wet as it

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 45.

had done in the firſt. In this way the ſame ſpring may affect all the other ſtrata of the ſame kind, of which the hill conſiſts, from the higheſt part down the whole of the declivity, and produce in the baſon, or hollow at the bottom, a lake or bog, ſhould there not happen to be a paſſage or opening to take away the water. In order effectually to drain hills of this kind, it is remarked, that it will be the moſt adviſable to begin by forming a trench along the upper ſide of the uppermoſt ruſhy ſoil, by which means the higheſt ſpring may be cut off; but as the rain and other water that may come upon the next portion of porous ſoil may ſink down through it, to the loweſt part, and produce another ſpring, a ſecond cut muſt be made in that part to prevent the water from affecting the ſurface of the ſucceeding clayey bed. And ſimilar cuts muſt be formed ſo far down the declivity as the ſame ſprings continue in the ſame way to injure the land, and in ſome caſes a ſufficiency of water may probably be obtained to irrigate the land below, or for ſome other uſeful purpoſe.

It ſometimes happens, however, that the ſtrata of which hills are compoſed are diſpoſed with ſuch regularity, as has been already ſhewn, that the water contained in them may be capable of being taken away from either ſide on the ſame level, a circumſtance which might be in ſome caſes advantageouſly applied in draining one ſide, and watering the other, as there is frequently on one ſide wet ſwampy ground, while on the other it is much too dry for the purpoſes of healthy vegetation. This often ariſes from the retentive body of clay that keeps up the water not being diſpoſed in a horizontal or ſlanting direction, but having a dip or depreſſion more to one ſide than the other, and from the dry ſide being overlapped by a ſtratum, or covering of clay, on which account the water is under the neceſſity of iſſuing at the open ſide; but when a paſſage is afforded it on the dry ſide, by a drain or trench lower than that by which it paſſes off on the wet ſide, the courſe of the water below may be changed without much difficulty *. From the oppoſite ſide being porous and ſandy, it becomes a reſervoir for the reception of the rain water, which afterwards diſcharges itſelf through the opening formed in the clay ; a circumſtance which may be of much utility in furniſhing water for domeſtic uſes, in caſes where the ſituation, in reſpect to the hill, will admit of it, and thus render the additional expence of conveying it by other means unneceſſary. Where a reſervoir of water is confined in a low ſituation contiguous to higher land, it may often be raiſed ſo as to ſupply houſes, or be otherwiſe uſeful, notwithſtanding it is much below that level, by confining

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 47.

it in a pipe or narrow brick opening. For the reſervoir or collection of water whence the ſpring or outlet of water is furniſhed being pent up, and confined between two impervious ſtrata, and the higher part of it extending probably in many caſes to a great height and diſtance in the elevated ground, it is plain that if a hole, or perforation, be made through the ſuperincumbant ſtratum, into the loweſt part of the porous bed containing the water, it may be raiſed by being confined nearly as high as the level of the head of the reſervoir, or collection of water. In conducting drains for ſuch purpoſes as theſe it will, however, always be neceſſary to be cautious not to cut or bore in them ſo deep as to reach a porous ſtratum, as by that means the water that had been found in one ſituation might be thus let down and loſt in another *. Theſe different caſes of draining may be better underſtood by the plate.

The poſſibility of raiſing water in particular ſituations by different methods of this nature, has been fully ſhewn in various inſtances, in digging wells and pits to great depths.

Methods of draining mixed ſoils.—Where the ſoil is of a mixed and varied nature, but the moſt prevailing parts of the clayey kind, the buſineſs of draining is conſiderably more tedious and difficult, than where the ſuperficial and internal parts have greater regularity. In ſuch ſorts of lands, as all the different collections of water are perfectly diſtinct from each other, by means of the beds of clay that ſeparate them, each collection becomes ſo much increaſed, or accumulated, in the time of heavy rains, that they are filled quite to the level of the ſurface of the clay, by which they are ſurrounded, when the water getting a free paſſage, as it would over the edges of a bowl or diſh, overflows and ſaturates the ſurface of that bed of clay, in ſuch a manner as to render it ſo perfectly wet and ſour, that its produce becomes not only annually more and more ſcanty, but the ſoil itſelf more ſterile and unproductive.

From the ſand beds in ſuch caſes having no communication with each other, it muſt evidently require as many drains as there are beds of this kind, in order fully to draw off the water from each of them. A drain or trench is therefore recommended to be cut from the neareſt and loweſt part of the field intended to be drained, up to the higheſt and moſt diſtant ſand bank, in ſuch a line of direction as, if poſſible, to paſs through ſome of the intermediate ſand beds, and prevent the labour and expence of making longer cuts on the ſides, which would otherwiſe be requiſite; but where many awkward turnings in the main trench would be the conſequence of this, and would lengthen it, and where, by

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 48.

paffing acrofs the beds in parts higher than the furface of the clay which furrounds them, it would greatly increafe its depth, and be worked with difficulty, efpecially when rock or running fand, drains, made fomewhat in the fhape of a Y, fhould branch off to the different beds, in order to take off the water they may contain, and convey it into the principal one, as fhewn in the plate*.

But notwithftanding the fand beds let the water they contain out on every fide, in fuch a way as to injure the clay furface quite round them, it is further obferved, that a drain made on one fide, may be fufficient to completely draw off the water from the whole, and hinder it from burfting out at either fide, if the place where it is cut be the loweft, or moft depending. But unlefs the drain be fo cut, it cannot poffibly have this effect, while the water can meet with a paffage on the contrary fide of the bank, lower than the bottom of the drain. This circumftance muft, therefore, in the firft place be attended to; and by a careful examination of the ground, and the application of the level, the moft proper fide and fituation for the drain may be readily afcertained. And when the water breaking out round the bank has been feen in dry feafons to run at one part, and not at the others, it is a fign that that is the loweft point, and that by cutting the drain on the line of that level, the water may afterwards be prevented from rifing fo high as the upper outlets, or above the level of the bottom of the drain, even in the moft wet times of the year †.

But, befides the lands conftituted in this way, there are others that have much fimilarity, only the different beds are of lefs extent, and lie together with greater regularity, in confequence of which they can be drained in a more eafy manner with lefs cutting, and of courfe at lefs expence. Below the layers or beds of fand and clay that lie, in this manner, alternately together, and nearly parallel to each other, is, generally, it is remarked, a body of impervious clay, which keeps up the water that is contained in the fand, and which being conftantly full, renders the adjacent clay moift, and in wet feafons runs or trickles over it. As in thefe cafes the principal under ftratum of clay is rarely above four or five feet below the furface, a drain is advifed to be cut to that depth through the middle of the field, if it have a defcent from both fides; but if it declines all to one fide, the drain muft be made in that place, as the water will more readily difcharge itfelf into it; and, unlefs the field be of great extent, and have more depreffions or hollows in it than one, one drain may be quite fufficient for the pur-

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 65. † Ibid, 66.

pofe, as by crofling the different beds that retain the water it muft take it off from each of them ;—as may be feen in the plate *.

A principal difficulty in draining ground of this nature, and which renders it impracticable by one drain, is when the direction of the alternate layers, or beds of clay and fand, lie acrofs the declivity of the land, fo that one drain can be of no other fervice than that of conveying away the water after it has paffed over the different ftrata, and would naturally ftagnate in the loweft part of the field, if there was no other paffage for it. Where the land lies in this way, which is frequently the cafe, it will therefore, it is remarked, be neceffary, befides the drain, in the loweft part, to have others cut up from it in a flanting direction, acrofs the declivity, which, by crofling all the different veins, or narrow ftrata of fand, may be capable of drawing the water from each of them ;—as fhewn in the plate †.

We have already explained the method to be purfued in draining, where fuch alternate ftrata are more extenfive, and the wetnefs produced by larger fprings, fo as to form fwamps, at very different heights or levels, on the fides of fuch hills, or elevated grounds.

In the draining of mixed foils of this kind, it will always be firft neceffary to afcertain, with accuracy, the inclination of the alternating ftrata, or the pofition of them, in refpect to the field to be drained, as this muft in a great meafure guide the direction of the drains. This may be effected in moft cafes from the appearances of the furface of the ground, the nature of the herbage, and other circumftances, as has been already fhewn.

In drains under thefe circumftances there is rarely any neceffity for perforating the bed below, as the required depth of the trench is fully fufficient, and as there is either no refervoir of water, which from the want of connection with higher land can rife up through the perforations, or it is at fuch a depth, and under fuch a body of clay, that it cannot be injurious to the furface ground ‡.

In thefe cafes it is recommended that the drains, after being formed at the bottom, in the manner of a fough, or fet in the way of a triangle, be filled fome way up by fmall ftones, tough fods being applied green fide downwards upon them before the mold is filled in. But where ftones cannot be readily procured, faggots may be employed in their place, where they are plentiful : the under part of the drain being laid, or coupled with ftones, fo as to form a channel or paffage for the conveyance of the water that may fink through the faggots,

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 67. † Ibid, p. 68. ‡ Ibid. 69.

and for the purpofe of rendering them more durable; as where the water cannot get freely off, which is generally the cafe where there is not an open paffage made of fome folid material, it muft, by its ftagnation, foon deftroy the faggots, and choke up the drain *.

In fully accomplifhing the drainage of fuch kinds of foils as thefe, attention fhould always be paid, where the land is much on the defcent, to mark out the branching drains in a fufficiently horizontal direction, fo that the fall may not be too rapid, by which the bottom of the trench may be rendered uneven, and the paffage of the water be thus impeded, which might foon force them up and make them ufelefs; but the fall fhould, however, be fo much as that the water may fully clear its way. The circumftance that renders fewer drains neceffary in fuch lands as have a horizontal pofition, is, that the water is brought equally from the fides of them, while thofe on a floping direction only draw from the upper fide of the drains, confequently require them to be more numerous and clofer to each other. Indeed, in all fituations where furface draining is to be had recourfe to, this is the cafe; but it is more particularly fo in fuch forts of grounds as have a retentive fubftratum, on which the porous furface materials are depofited.

Soils conftituted of beds of clay and fand, in the manner that has been juft defcribed, are fometimes characterifed and known in places where they are very prevalent, as fome parts of Lancafhire, by fuch terms as have a relation to the circumftance of their holding water, in the way that fome kinds of veffels do †.

Sometimes, too, the water is found to be retained in fmall beds of folid rock, that are croffed and intercepted by beds of clay ‡.

Methods of draining retentive foils.—The practical mode of drainage in fuch foils as are compofed of porous materials above, and fuch as are retentive below, or the contrary, is materially different from that which has been defcribed above. Many tracts of level land are injured by the ftagnation of a fuperabundant quantity of water in the upper parts of the furface materials, which does not rife up into them, from any refervoirs or fprings below. The removal of the wetnefs in thefe cafes may, for the moft part, be effected without any very heavy expence. From the upper or furface foil in fuch cafes being conftituted of a loofe porous ftratum of materials, to the depth of from two to four or five feet, which has a ftiff retentive body of clay underneath it, any water that may come upon the furface from heavy rains, or other caufes, readily filtrates and finks down through

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 69. † *Sand-pots*, or *gut.* ‡ Ibid 70.

it, until it reaches the obſtructing body of clay, which prevents it from proceeding; the conſequence of which is, that the porous open ſoil above is ſo filled and ſaturated with water, as to be of little utility for the purpoſe of producing crops of either grain or graſs. Land ſituated in this way is frequently ſaid to be wet bottomed by farmers: in order to remove this kind of wetneſs, it ſeldom requires more than a few drains, made according to the ſituation and extent of the field, of ſuch a depth as to paſs a few inches into the clay, between which and the under ſurface of the porous earth above, there will obviouſly be the greateſt ſtagnation, and conſequently collection of water, eſpecially where it does not become much viſible on the ſurface. In theſe caſes there is not any neceſſity for having recourſe to the uſe of the boring inſtrument, as there is no water to be diſcharged from below.

When the field to be drained has only a ſlight declination, or ſlope, from the ſides towards the middle, one drain cut through the porous ſuperficial materials into the clay, in the loweſt part of the ground, may be ſufficient to bring off the whole of the water detained in the porous ſoil. This effect may likewiſe be greatly promoted by laying out and forming the ridges ſo as to accord with the direction of the land, and by the uſe of the plough or ſpade in removing obſtructions, and deepening the furrows, but which may be better underſtood by the plate*. In ſuch ſituations, where the drain has been formed in this manner, the water will flow into it through the porous ſurface materials, it is obſerved, as well as if a number of ſmall trenches were cut from it to each ſide, as is the practice in Eſſex, and ſome other parts of the country; but which is evidently an uſeleſs and unneceſſary labour and expence, and beſides the field is greatly injured by ſo much cutting. The drain made in the hollow may frequently ſerve as a diviſion of the field, in which caſe it may open; but in other circumſtances it may be more proper to have it covered †.

Where a field of this deſcription has more than one hollow in its ſurface, it is remarked, that it will obviouſly be requiſite to have more than one main drain; but when it is nearly level, or only inclines ſlightly to one ſide, a trench or drain along the loweſt part, and the ridges and furrows formed accordingly, may be ſufficient for effecting its drainage:—as may be ſeen in the plate. There may, however, be caſes, as where a field is large and very flat, in which ſome ſide cuts from the principal drain may be neceſſary, which muſt be made a little into

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 71.

† Ibid, p. 72.

the clay, and as narrow as they can be wrought, and then filled up with ftones or other fuitable materials, in the manner that will be prefently defcribed. Thefe points may be better underftood by the plate.

But though this is the plan that is to be purfued in draining foils where the porous body is upon the furface, there are other more extenfive cafes of ground which are alfo much injured from wetnefs, but in which the foil is formed in a directly oppofite manner, the clay fubftance conftituting the furface, and the porous body being underneath. We have already pointed out the methods of proceeding in cafes of this kind, where the wetnefs of the land is fuch as to do great injury, and where the retentive bed or ftratum that keeps up the water is of fuch a depth as to be under the neceffity of being perforated, or bored through by means of inftruments. But, from the depth of the drain itfelf being in thefe cafes fufficient to penetrate to the porous ftratum below, the mode of draining them is to be noticed in this place.

In general, lands of this nature lie extremely flat, and without the leaft declivity, by which the injurious ftagnant water on the clay furface can poffibly get off, without the affiftance of drains being formed for the purpofe; but in foils of the fame fort where the fituation is more of a declivity, there is rarely any bad effects from the fame caufe. Soils of this nature are however drained with greater difficulty, and require a much greater number of trenches or cuts, than thofe of any other kind, as they muft be marked out and difpofed in fuch a way as to collect and convey the water every-where from the furface; as it can only force itfelf off into them from above, being prevented from finking in through the clay, as in thofe foils of a contrary kind. Where there happens to be hollows or irregularities in the furface of the land, water may often be obferved to continue ftanding in them, at the diftance of but a few feet from the drain. In draining fuch lands, it will, it is obferved, always be neceffary, in the firft place, to make a large or conducting drain at the loweft part, or the end of the field, for the purpofe of receiving and conveying away the water collected by the lefs collateral cuts, which it may be neceffary to make on each fide of it. Where it fuits for the purpofe of dividing the land, this principal drain may be better to remain open than be covered, as by that means the mouths or outlets of the different fmall drains that come into it may be conveniently examined, and cleared out when neceffary *.

In fuch foils too, when they are under tillage, the conftruction of the ridges,

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 74.

ſo as that they may accord with the declivity, is a matter that muſt be carefully kept in view. They ſhould in all ſuch caſes have alſo that degree of elevation or roundneſs in the middle that may be ſufficient to afford the water ready fall into the furrows, which ſhould likewiſe have ſuch a depth and fall as may take it quickly into the drains. The ridges, beſides being well laid up, ſhould have ſmall open drains formed in a ſlanting direction acroſs them, in ſuch a manner as to form communications with one another, and with the furrows ; by which means they are made to perform the office of drains, the water coming upon the ridges being thus readily conveyed into the furrows, where it proceeds till impeded in its courſe by the riſing of the ground or other cauſes, it then paſſes through the open croſs-drains into others, where the deſcent is greater, and is ultimately conveyed off into the ditch, or other paſſage, at the bottom of the incloſure. The elevation of the ridges ſhould probably too be made greater for the winter than the ſummer crops, as there muſt be much more injurious moiſture at the former than the latter ſeaſon. This may be eaſily accompliſhed at the time of ploughing the land.

By theſe means, therefore, a large portion of the rain water might be conveyed off as it falls, and the number of ſmall cuts that would otherwiſe be required, be much diminiſhed. The drains, when neceſſary, ſhould alſo be cut as narrow as poſſible, and be filled up with ſmall ſtones in the way that has been noticed; and the bottom or ſough of the principal or conducting drain, where it is not an open one, ſhould be formed with a ſmall channel or conduit at the bottom, in the way that has been mentioned, in order to facilitate the paſſage of the water. It is the beſt method too to form the ſmall drains by what is termed *coupling*: that is, placing the ſtones in the bottom, in an inclining direction on one another, ſo as to form a ſort of triangular opening of from four to ſix inches underneath. From the water being wholly brought in from the top of the drains, it is requiſite that they be filled with ſmall ſtones up to ſuch a diſtance from the ſurface, as will juſt admit the plough or harrow to paſs over without diſturbing them, which ſpace ſhould be covered in with looſe gravel. Where ſuch gravel can readily be procured it is always to be preferred, to the tenacious clayey earth that came out of the trench, from its more readily admitting the water to filtrate and paſs through it into the ſtones. A thin coat or layer of ſtraw or ruſhes, or what is ſtill better, where the land is in a ſtate of paſture, the ſurface turf pared thinly off, muſt be applied over the ſtones, in order to guard againſt the ſmaller parts of the gravel from inſinuating themſelves, and filling up the openings be-

tween them. This is not, however, fo neceffary to be done when gravel is ufed, as when mold is the material made ufe of *.

This method of removing water from land is, it is obferved, fuited to every tenacious clay foil, whether it be porous or not below; but in many cafes deepening the furrows with very few drains might prove fufficient for remedying the injury, where the retentive upper foil is only of the depth of a foot or two, with an open or porous material beneath it, through which the water could readily fink downwards, and be difcharged again at fome lower part of the field. The drains and furrows ought confequently to be deepened quite through the clay into the porous foil, in order to fully expedite the defcent and difcharge of the water. Hence it is obvious, that a great deal depends on the judicious ploughing of fuch land, as by it the labour of cutting might be much abridged, or perhaps nearly prevented.

Much may likewife be effected in many cafes of clayey foils, both of the deep and thin kinds, by breaking and opening them well up, to fuch depths as may allow the water to fink down to fuch a diftance as will render it not prejudicial to the crops that may be cultivated upon them; and by the incorporating of dung and calcareous manures with them in large proportions, as may be feen by the effects of deep trenching in the bufinefs of gardening. This fhould be performed by fuch implements as operate deeply, without turning the mellow furface mold down underneath †.

When hollow drains are neceffary, in digging of them there is confiderable art, as they fhould be formed with as much truth and exactnefs as poffible, which can only be done by fuch perfons as are converfant with the nature of the bufinefs. Such labourers as are not dexterous in ufing their tools feldom make them well. The moft general method of performing this fort of work is by admeafurement, at fo much a rod, or a fcore rods, which neceffarily induces the workmen to do as much as they poffibly can; they fhould therefore be frequently infpected, to fee that they keep to the proper and required depth, and that the earth taken out be laid in fuch a manner, as not to fall down again into the drains in time of filling them, and that the furface mold be kept on one fide free from the clayey or other material of the inferior ftratum ‡.

Thofe who have been in the habit of draining land, now in general begin to

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 74.

† See Anderfon's Practical Treatife on Draining, p. 99. ‡ Ibid., p. 149.

fee the great advantages of making their drains, in thefe cafes, when there is any declivity in the ground, in a flanting direction acrofs it, inftead of the old method of conducting them according to the nature or inclination of the flope. By attending to the former mode of cutting the drains, the wetnefs is not only more effectually removed, but, by allowing the water to pafs away in an eafy current, they are rendered lefs liable to be choked, or as it is frequently termed blown up, by which artificial oozings of water are fometimes formed in fuch places. But where grounds are either quite or nearly level, as is the cafe in many of the weftern diftricts, it has long been a general practice, and where the wetnefs to be removed arifes entirely from furface water, by no means to be difregarded, to cut the drains at the different diftances of about fixteen, twenty-four, and thirty-two feet from each other, acrofs the fields from the different ditches, according to the circumftances of the lands; or, indeed, where the drains, either from fome flight unevennefs of the furface, or other caufes, can only be made to flow at one end, to avoid cutting them further on one fide, than where the ditch is capable of taking away the wetnefs. In cafes where the declivities of a piece of ground are various, and have different inclinations, the drainer fhould conftantly attend to them, and direct the lines of his drains in fuch a manner, as that they may crofs the higher fides of the different declivities in a flanting direction.

The depth of all fuch drains muft depend upon the nature of the foils, the pofitions of the land, and a great variety of other more trifling circumftances. It was formerly the cuftom to make them three or four feet in depth, but by modern drainers they are rarely made to exceed thirty, or perhaps a few inches more, the moft general depth being from twenty-four to twenty-fix inches. As the main drains have more water to convey away, and are generally of greater length, than the lateral ones, they fhould always be cut fomewhat deeper; and where the materials of the foils are porous, the greater depth they are cut, the more extenfively they act in lowering the wetnefs of the land, to fuch a degree, as that it can be little injurious to the crops, whether of grain or grafs, that may be produced upon it: when, however, the operator reaches any impervious material in the foil, through which the moifture cannot pafs, it will be quite ufelefs to dig the trench to a greater depth. If it be clay, by going a few inches into it, a more fafe paffage for the moifture may however be fecured. It muft notwithftanding be invariably attended to, that the depth be fuch as that the treading of heavy cattle may not difplace, or in any way injure, the materials employed in conftructing or filling them. It may be noticed too, that where the

horfes in ploughing tread in the bottom of the furrow, at the depth of four or more inches below the furface, that, if eight or ten more be allowed for the materials with which they are filled, when the depth of the trenches are not more than twenty-four inches, there will only be nine or ten inches of earth for the fupport of the horfes in the exertions of ploughing. Where the earth has been ftirred, fuch a depth muft undoubtedly be too little, and in fome meafure proves that drains of fuch a depth are not fufficient. By cutting them down to the depth of two feet and a half in the ftiffer foils, they will feldom be penetrated to, or have too great a depth; and in the pervious ones a ftill greater depth is highly ufeful, and conftantly to be practifed *.

The practice of cutting the drains as narrow as poffible, which has lately been much attended to in moft of the eaftern diftricts, is of much importance, as it caufes a confiderable faving of the matters employed in filling them up, whether they be wood or ftraw; but in cafes where bricks or ftones are employed, this cannot be fo much attended to; however, there is feldom, Mr. Johnftone obferves, a neceffity for a greater width than about a foot, provided the ftones be *coupled* at the bottom, or thrown in in a mixed way, nor more than fixteen inches where laid in the manner of a fough or channel. But of whatever depth the materials may be, the earth or mold by which they are covered up fhould not be lefs in depth than a foot, in arable lands it fhould indeed be more. The dimenfions reprefented in the plate are proper for fuch lands as are wet from furface water, or the ftagnation of it in the upper foil.

In lands in the ftate of pafture, efpecially where the foils are ftiff and tenacious, gravel, when it can be procured, is always to be preferred for filling with, and the earth thrown out may ferve for filling hollows in the fields.

It is an advantageous practice in fome cafes, as where the land to be drained is in fuch a ftate as to admit of it, to make ufe of the plough in opening the upper parts of the drains. The method of performing the bufinefs as defcribed by a celebrated drainer is this: when the drains are fet out in the field, which is commonly done at the diftance of about a rod from each other, two furrows are drawn with a foot-plough, a *baulk* of about fifteen inches in width being left between them, which baulk is then fplit, by means of a ftrong double breaft-plough conftructed for the purpofe, and a clean furrow fourteen or fifteen inches in depth left. In fome cafes, where the foil is fo deep as to require it, as it is advantageous to touch the furface of the clay, by a fecond ufe of the plough, the furrow is funk to the depth of eighteen or twenty inches; it is then in a ftate of

* See Johnftone on Draining, p. 147.

preparation for the land-ditching ſpade, by the uſe of which the drain may be dug to the depth of fifteen inches more, as narrow as it is capable of being made*.

When ploughs for the purpoſe cannot be readily procured, the buſineſs may be performed by means of a common plough, and a ſtrong team, ſo as to ſtir the ground to the depth of five or more inches, making a double furrow by throwing the earth on each ſide, and letting a baulk remain in the middle. This baulk is, Mr. Johnſtone ſays, to be raiſed in a ſimilar manner, by a ſecond bout of the plough, and then as much depth as poſſible is to be got by going twice in the open furrow with an ordinary double breaſt-plough. The looſe mold and irregularities are next ſhoveled out to the breadth of a foot, by which a clear open furrow is produced of different depths, according to the nature of the ſoil and the ploughs employed, but moſtly about eight or nine inches. One ſpit is afterwards dug out to the depth of fifteen or ſixteen inches, with the draining ſpade, producing ultimately a depth of two feet or more. Where this depth is not ſufficient, which is often the caſe, one or two ſpits more are thrown out, by which a depth of three or more feet is frequently formed.

As where a large quantity of water is made to flow in one drain, as from the junction of many collateral branches with it, though it be made larger and of greater depth in conſequence of that circumſtance, it may be liable to fail in taking away the water, the effect of which muſt be very extenſive, from the courſe of ſo many others becoming impeded in conſequence of it: it is a good rule, therefore, not to connect a number of drains with the ſame outlet, or diſcharging one; but to form them, eſpecially where there is much declivity in the land, as much as poſſible in a diſtinct and ſeparate manner.

The ſpades employed in forming the drains were formerly made of different ſizes, ſo as to follow each other, narrowing in breadth in a regular manner to the bottom. Lately, however, the plough has been made to ſupply, in the way that has been juſt ſhewn, the places of all of them except the lowermoſt, or the two lowermoſt ones where the drains are required to be deep. Scoops are likewiſe uſeful tools in this buſineſs, as by drawing them along the bottom of the drains all the looſe and detached particles of earth may be cleared away, and they be prepared for the materials with which they are to be filled †. Im-

* See Annals of Agriculture, vol. VIII. p. 164.

† The expence of making drains, it is obſerved by the writer of Mr. Elkington's Mode of Draining, muſt neceſſarily vary, according to the particular circumſtances of the caſe. In the county of Suffolk, as ſtated in the Agricultural Report of the county, the expence of digging out and filling two ſpit drains is from three ſhillings and four pence to three ſhillings and ſix pence a ſcore rods, without any allowance of beer. But

plements of this fort of various dimenfions fhould be had, in order to fuit the different fizes of the drains ;—reprefentations of which may be feen by confulting the annexed plate.

Various implements of other kinds, in fomewhat the forms of ploughs, have been invented at different periods for the purpofe of forming hollow drains at once in land, but hitherto we believe without that general fuccefs which might be wifhed for in fuch inftruments. That which was not long ago invented by Mr.

But in Effex, according to Mr. James Young, they pay for digging out the land drains one fhilling and eight pence, and for filling them with ftubble four pence per fcore rods without beer; and an expert workman, where the land is not ftony, is capable of digging twenty-three or twenty-four rods in a day, or within working hours.

He eftimates the expence, or the money that the farmer pays out of his pocket, for draining an acre of land in this way:

	£.	s.	d.
For cutting and raking together an acre of wheat ftubble, moftly fufficient for an acre of drains - - - - - - -	0	2	0
Digging eight fcore rods of drains - - - - -	0	13	4
Filling them up with ftubble - - - - - -	0	2	8
Extra work with the common fpade, averaging a day's work for a man -	0	1	4
	0	19	4

It is obferved by Lord Petre, that the value of the work is different according to the method purfued. His mode is that of ploughing with a common plough, and pair of horfes, two furrows different ways, leaving a baulk in the middle, which he afterwards ploughs out with a large plough, and three horfes abreaft, which regularly turns a furrow about two inches deeper than the land is commonly ploughed. The expence, without allowing any thing for the perfon who attends, and marks out the ditches, is, he fays, about one fhilling and fix pence per acre, the drains being a rod apart. This is the mode for fallows. The labour of digging is two-pence farthing or two-pence halfpenny the rod, and the expence for the acre of the whole work is, as near as he can guefs, on a fallow, where two fpits are dug, four pounds three fhillings and fix pence per acre; with the plough, and one fpit, about three pounds; with the plough, about one pound fifteen fhillings; without the plough, and the fpits, on clay fet, about two pounds feven fhillings per acre.

According to Mr. Majendie's information, his expence is:

	s.	d.		s.	d.
Digging the drains with the fmall or laft fpit fpade per fcore yards	1	8	to	2	0
Two fpits in main drains - - - - -	3	0	to	3	6

In this manner the under-draining one acre (the drains at one rod apart), including wood, ftraw, and all other incidental charges, amounts to an expence of from two pounds to two pounds five fhillings.

It is ftated by Mr. Kent, in fpeaking of the conftruction of drains with the fpade and the ploughs, that it is rather difficult to make an exact eftimate of the expence, as the price varies, in the county of Effex itfelf, from one penny to three pence per pole, in the workmanfhip only; and fome land re-

Adam Scot, termed a mole-plough, and which has ſince, perhaps, been in ſome degree improved by Mr. Watt, of Bingley, may anſwer in ſome particular kinds of ſoil, at certain ſeaſons of the year; but from the great ſtrength which is required to draw it, it is obvious that it can only be employed under peculiar circumſtances of ſoil, ſeaſon, and ſtrength of team. However deſirable it may therefore be, to have an effective implement of this kind, that may be generally made uſe of, and which performs its work at a cheap and eaſy rate, it would ſeem that at preſent the farmer is not in poſſeſſion of one that can be conſidered as fully adequate to the purpoſe.

There is another ſort of inſtrument, invented for the purpoſe of draining, and which has been made uſe of in Eſſex: it is a heavy wheel, with a ſharp cutting edge. In the ſurvey of that county it is remarked, that the wheel is conſtructed of caſt-iron, weighs about four hundred weight, and is four feet in diameter; that the cutting edge, or extreme circumference, is half an inch in

quires the drains to be nearer together than others; but ſuppoſing them to be a pole in width from each other, which is the common diſtance, the following calculation, upon an average, will be pretty exact for an acre:

	£.	s.	d.
Sinking the ditch to obtain an outfall - - - - -	0	7	6
Drawing the furrows - - - - - - -	0	2	6
One hundred and ſixty poles of digging and filling up, at two pence -	1	6	8
Wood, eſtimated at a faggot of twelve feet long to a pole, carriage included, at four pence per faggot - - - - - -	2	13	4
Half a load of ſtraw, and carriage - - - - -	0	7	0
Extra-digging, in the ends, where the plough will not reach - -	0	1	6
	4	18	6

Mr. Middleton, in his Report of the Agriculture of Middleſex, ſtates the expence of draining on Enfield Chaſe to have been, for

	s.	d.
Common drains, twenty poles eighteen inches deep each - - -	3	0
Principal ditto, two feet deep of the ſame length - - - -	5	0
Beer to each ſcore - - - - - - - -	0	2

The labourer to find tools, and keep them in repair.

The uſual diſtance, a ſhort pole from each other.

In the Report of the County of Kent, the expence of this mode of draining is aſſerted to be from fifteen to thirty ſhillings the acre, according to the number of drains that may be required.

And in the Agricultural Survey of the County of Somerſet, it is ſtated, that main drains two feet and a half deep and two feet wide, in a heavy ſtrong clay ſoil, may be dug for one ſhilling and ſix pence per rope, of twenty feet, viz. nine pence per rope digging the drain and placing the ſtones, three pence per cart-load quarring the ſtones, and three pence per load halling. Each rope requiring one cart-load and half of ſtones.

Small drains, leading to the main drain, may be executed for ten pence per rope of twenty feet.

thicknefs, which increafes towards the nave or centre. At the depth of fifteen inches it will fcore or cut out a drain half an inch wide at the bottom, and four inches at the furface. It is placed in a frame in fuch a manner as that it may be loaded according to circumftances, and be made to cut a greater or lefs depth in proportion to the refiftance afforded by the land. After the ground has been fcored out in this way in the winter, the drains thus conftructed are then either filled by means of ftraw ropes, and flightly covered with earth, or left to be rendered wider and of greater depth by the cracks produced from their being expofed to the influence of the fummer's fun: the openings being afterwards filled by twifted ftraw or brufh-wood, and lightly covered over with mold or earth, of the moft porous fort that can be readily procured. In this way hollow drains are made on grafs or ley grounds at a trifling expence, which from experience have been found to anfwer well. It is likewife afferted by Mr. Young in the Annals of Agriculture, that twelve acres have been drained in a day by this wheel; and that it is found to execute the work in the moft effectual manner when the land is foft from moifture. This mode of draining would feem to be the moft adapted to fuch paftures and pleafure-grounds as have confiderable fmoothnefs of furface, without being trodden by heavy cattle, and which, from the retentive nature of their foils, detain the water that falls in rain.

A fort of plough, termed a *Miner*, and various kinds of common draining-ploughs, have been conftructed for the purpofe of opening up tillage-lands to a confiderable depth, fo as to allow the water to pafs away upon the impervious clayey material below the common furface foil. Thefe are reprefented in the annexed plate.

The beft or moft proper feafon for performing the bufinefs of hollow-draining, does not feem to be yet fully determined by thofe who have been moft engaged in the practice; fome contending that winter is the moft advantageous time for the purpofe, while others think that fummer fhould always be preferred. It would, however, appear, from the confideration of the different circumftances of the lands at thefe periods, that neither of them are the moft favourable feafons for this kind of work; but that the more early fpring months, when labourers can be procured, and it does not interfere with the other operations of the farmer, are by much the beft; as, in thefe, the difficulties arifing from the hardnefs of the foil, and the fcarcity of labourers, in the fummer feafon, and the kneading and plaftering, as well as the cutting of the land by the cartage of materials in the winter, are equally avoided. Befides, in thefe months the land is not only in the

moſt ſuitable condition for the workmen, but the danger of the new drains being deſtroyed in ſome ſituations by the floods cauſed by the autumnal rains, is guarded againſt.

Where, however, the farmer has a great deal of work of this kind to perform, it will be impoſſible to do it all in theſe early months: he muſt proceed with the buſineſs at other ſeaſons when froſt is not preſent. It is the moſt common practice of farmers to drain ſtubbles in the winter, and fallows in the ſummer months.

Some expert drainers, however, think this ſort of work much better performed when the land to be rendered dry is under a layer, or ſown down with ſeeds of the graſs kind. And it has been remarked that the plough employed for firſt opening the furrows performs better on land in this ſtate *.

As the limits between the wet and dry parts of land can be the moſt readily diſtinguiſhed when it is in ſummer fallow, and the little inequalities of ſurface be moſt eaſily levelled down, that period is by moſt farmers conſidered as unqueſtionably the moſt proper time for forming ſuch drains as are merely to convey away the ſurface wetneſs.

Different ſorts of materials may be employed for the purpoſe of filling drains, to which the drainer will be directed by the eaſe and facility with which they may be capable of being procured. Thoſe in moſt general uſe, are ſtones, wood, ſtraw, heath, and bricks conſtructed for the purpoſe.

Where quarried ſtones are employed, and the drain conſtructed at bottom in the manner of a conduit, the trench ſhould be made ſufficiently wide to admit two ſide ſtones, about ſix inches apart, and of equal height, a flat ſtone being placed over by way of cap; and thus a ſecure drain formed. Another mode of conſtructing ſtone drains, and which has been found conſiderably cheaper and more ſecure, is that of uſing three ſtones of a thin, flat form, placing one againſt each ſide of the drain, ſo as to join at the bottom, and capping or covering them with the third; thus forming a ſort of triangular paſſage for the water. When made in this way, it is ſaid that they are neither

* It is ſtated by the author of Mr. Elkington's Mode of Draining, that "Lord Petre prefers a lay, if laid down level, as he has a plough conſtructed for the purpoſe on very ſimple principles, which with ſix horſes he can plough from ten to twelve inches, and lay the furrows as regular as if they had been done by a ſpade; ſo that after the drain is digged and filled, the furrow can be returned to its place again, and rendered quite level by a heavy roller. He only digs one ſpit fourteen inches deep with the bottom land-ditching ſpade. The expence is 2s. 8d. for twenty rods; the digger returning the furrow to its place. He employs the ſame plough on fallows; but it does not anſwer ſo well in that caſe, as the mold falls down into the furrows. The expence of digging in this caſe is 1s. 2d. for every rod."

fubject to be filled up, nor to obftruct the current of water that may pafs along them. They do not, like thofe formed in the ufual way, caufe obftruction by finking unequally into the ground; but by fubfiding in a regular manner all together, keep the courfe for the water free. Befides, in this mode, a lefs quantity of ftones is generally required; which is a circumftance of great importance in many fituations. The firft method is, however, only applicable in cafes of fprings; but this, as well as the mode juft mentioned, is obvioufly much more expenfive than that of throwing in fmall ftones in a loofe manner.

In particular diftricts, as Effex, and fome other eaftern counties, where drains are filled with ftones, they employ the fmall flints from the chalk or ftones from gravel-pits, or fuch as are picked from the land. But it is only in drains of very little extent, and where little water paffes, that fuch very fmall ftones can be ufed with fafety and advantage; and as ftones, of whatever fize they may be, require a greater width in the bottom part of the drain than where wood or ftraw is made ufe of, the expence of forming them will be confiderably more. In every cafe the ftones ufed fhould be perfectly clean and free from clay, or any other earthy matter that may adhere to them, and be placed in the drains in fuch a manner as that none of the mold or earth may get in along with them, which might be detrimental by filling up the holes and crevices between them.

It has been afferted by fome, that drains filled with wood, and covered in the common way with ftraw or rufhes, are fuperior to ftones or any other kind of materials, for as the wood decays the water continues to pafs. But that when filled with ftones, and the drains ftop up, which in time muft often be the cafe, the earthy matter becomes quite folid round the ftones, from their not decaying, and the paffage of the water for ever prevented; which is not the cafe where bufhes or wood are employed, an oozing or draining being conftantly perceptible. Befides, by a repetition of the bufinefs, and making the drains in a tranfverfe direction to the old ones, the advantage of filtration through the rotten wood is preferved, and the fpewing up of old broken and injured drains removed and carried away. It has been further obferved, that as bufhes form more numerous cavities than either ftones or poles, they are lefs liable to be ftopped up, while the percolation or paffage of the water is promoted more than by fubftances of a larger and more folid kind *.

Black thorns are preferred by fome, from much experience, to all other forts of

* It has been found that a load of bufhes containing one hundred and twenty faggots, will complete about three hundred and fixty rods; and a load of ftraw of one hundred and twenty bottles will do the

materials for the purpofe of filling drains, probably from their not decaying fo quickly as many other forts of wood, and their affording an eafy and free paffage to the water by their bufhy nature.

By fome it is a practice to employ wood in filling drains, by depofiting the faggots or brufh wood which is made ufe of, upon fmall bunches of wood in the form of billets fet upright in the bottom of the drain. But though this method is faid to have fucceeded in fome of the more northern parts of the ifland, and is perhaps capable of being practifed with advantage in fuch lands as are not under the ftate of arable cultivation, it has been found that in fome cafes the feet of the animals employed in ploughing have funk in fuch a manner as to remove the materials that fupported the brufh wood, and by that means obftructed the paffage of the water. Where this mode is followed, efpecially in lands that are to bear the treading of cattle, care fhould be taken to have a confiderable thicknefs or depth of earth upon the drains. It is remarked by the reporter of the ftate of agriculture in the county of Caermarthen in Wales, that the moft complete method he is acquainted with, is that of cutting the ftrongeft parts of willows, and other aquatic plants, into lengths of about twenty inches, and placing them alternately in the drain, one with the end againft one fide of the bottom, and the other with it againft the oppofite fide, fo as to form a fort of crofs-work. The ftronger parts of the wood being laid in this way in the drain, the fpace between on the upper fide is filled with the fmall twigs or brufh wood that has been left, and the whole is finifhed by a flight covering of ftraw, rufhes, or fuch-like fubftances, being laid over them. It has been obferved, that the boughs of willow, alder, afp, and beech, are extremely durable when put in fuch drains in their green ftate before the fap is dried up; but that when fuffered to become dry before they are put under the ground, they decay more quickly. The reporter has feen willow taken out of a bog where it had laid thirty years, with the bark frefh and fappy as if juft cut from the hedge; and it is well known, he remarks, that beech laid in the water green will continue found for almoft any length of time.

It has likewife been remarked by an able agricultor, Mr. Majendie, that wood of eighteen years' growth, is much more durable than fuch as is only ten or twelve.

On filling drains with ftraw, where the foil is a clofe retentive clay, it is ad-

fame: the bufhes are moftly worth fourteen fhillings, and the ftraw eighteen fhillings, the load. The expence is therefore eftimated at about twelve fhillings an acre, the ditches being made about a rod diftant from each other.

vifed that the drains fhould be made near to each other, fhallow, and filled with that material only, as it is quite unneceffary to employ wood or other more durable materials, where the fides of the drains are not likely from the nature of the land to crumble down into them. In fuch cafes, the diftance of the drains fhould feldom be greater than three or four yards from each other, and about twenty inches in depth; or fuch as may be eafily produced by firft ufing the plough, then fhovelling up the bottom of the loweft furrow, and afterwards taking out one fpit with the land-ditching fpade: drains formed in this way, with the materials, coft about two fhillings and fix pence a fcore rods.

It is further remarked, that drains cut through tough retentive clays, and managed in this way, will be found foon after they have been made to have formed over the ftraw employed in filling them, an arch of fuch ftrength as to fupport the weight of the foil, and any thing that may come upon it in the courfe of managing the land; and that in the courfe of twelve or eighteen months, from the ftraw being an uniform fubftance, it is wholly rotted and conveyed away, leaving clear open pipes in fuch drains, as the water may have had a free and eafy paffage into, by a proper attention having been paid to the filling of them with the moft open and porous parts of the furface of the land *.

But the beft method of filling hollow drains with ftraw is probably that which has been lately practifed of twifting it into ropes. The mode which has been moft generally followed, is that of treading into the drains loofe ftraw; but it may be forced much more effectually to the bottom of the drains, and convey the water away much more readily, and be alfo of much longer duration, by being wound into a firm hard rope, about the fize of a fmall cable, while the bufinefs of filling the drains is rendered more expeditious, and the quantity of ftraw which is neceffary not by any means increafed. This method has been practifed by Mr. Bedwell, in the county of Effex, with great fuccefs and advantage, and who has found that the ftraw is tougher and in a better condition for winding after it has been picked over by cattle, than in its frefh and dry ftate. A reprefentation of a machine for this purpofe may be feen in the annexed plate.

Bricks are fometimes made and employed for the purpofe of draining, but they are in general too expenfive, and not well fuited to furface draining, though they are proper for fuch drains as are to carry off the water iffuing from fprings, in which cafes a large tract of land may frequently be laid dry, without employing any very great quantity of fuch materials. The bricks ufed in this way have moftly

* See Vancouver's Report of the County of Effex.

an excavation for the water to paſs along, and are placed in ſtiff ſoils upon the bottom of the drains; but in ſuch as are ſoft, they are moſtly laid one upon the other, ſo as to form a ſort of cylindrical paſſage for the water; or they may be placed on a foundation made of common bricks: repreſentations of bricks for this uſe may be ſeen in the plate.

Pipes made of burned clay, about eighteen inches in length, having an opening three or four inches in diameter, are alſo made uſe of in this way in the county of Eſſex, and ſome other diſtricts; but from the narrowneſs of their apertures they can only convey a ſmall quantity of water, they are therefore more ſuited to the conveyance of water from ſprings or other places for domeſtic uſes, than for the purpoſes of draining land.

As it is a matter of conſiderable importance in the buſineſs of draining, to have the work properly executed, on this account the perſons who perform the cutting of the drains ſhould not be contracted with for the filling of them, but merely for the cutting and leaving them clean in the bottoms. The filling being performed by labourers hired by the day, in order to guard more effectually againſt negligence, and the want of proper attention to the work; and even when done in this way, either the farmer himſelf, or ſome other perſon who can be truſted, ſhould frequently inſpect the performance. It is obſerved by an ingenious drainer, that it is an invariable rule with him never to ſuffer the man who digs to cover up the drains, they being left for him or his bailiff to inſpect; they are then filled up well to the ſhoulders with wheat ſtubble, cut and ſtacked for the purpoſe immediately after harveſt; and a ſmall ſtick or two put at the outlets to prevent their being ſtopped up by accidents: after this he turns a furrow of the upper ſoil or mold upon the drain by means of a common plough, taking care not to turn in any of the dead ſoil brought up by the land-ditch ſpade, which ſhould always be laid on the outſide, and be ſpread over the land. It is proper, he ſays, not to let the drains lie open any great length of time, as they may get injured by wetneſs or froſt; his general rule is to fill them up in the courſe of the day *. By conſulting the annexed plate, the methods of filling drains in different caſes may be better underſtood.

Methods of draining mines, quarries, and pits.—Beſides the removing the injurious wetneſs of land ariſing from ſprings, and that on the ſurface cauſed by the ſtiff and retentive nature of the ſoil, there is another application of the principles which have been explained, which is in the draining of mines, quarries, and

* Mr. James Young, of Clare.

ſuch pits as have been formed in the digging of marl or other ſubſtances of a ſimilar kind, where they are prevented from being wrought by it.

As the injurious water is brought down from the more elevated ſituations through the porous ſtrata of materials at conſiderable depths, as has been already ſhewn; where pits, mines, or quarries, happen to be formed at the bottom of ſuch declivities, and are inconvenienced or wholly obſtructed, either in the digging or working, by the water contained in them, it may be poſſible, in many caſes, to prevent its coming into ſuch mines or pits, by cutting or boring into the loweſt edge of the porous ſtrata where the level of the ſituation in which it is, is lower than where it lies in the pit or mine. In order to accompliſh this object, it will be neceſſary to aſcertain if any porous ſtratum preſents itſelf higher up the elevation than the place where the mine or pit is formed, that may conduct the water it poſſeſſes to the porous body that is below it; as where ſuch a ſtratum is diſcovered by cutting into it, much of the water may be drawn off and prevented from paſſing down. But, notwithſtanding the water from above may be cut off in this way, a quantity ſufficient to inconvenience the working of the mine or pit may ſtill filtrate from the ſides of the porous bed, even though it may incline in the direction of the lower ground. When this is the caſe, it may, however, be readily taken away at ſome place in it. To accompliſh this, and thereby obviate the effects of the water, the termination of the porous ſtratum below the pit muſt be aſcertained; and where there is any mark of a natural outlet at the place, a large drain ſhould be formed, in order to admit the water to flow off with more expedition. Where, however, there is a thick bed of ſome impervious ſubſtance, ſuch as clay, placed upon the termination of the porous material, the drain need only be cut a little way into that, as by boring through the reſt a ſufficient paſſage may be given to diſcharge the water. In this way, the draining of ſuch grounds as lie above or near to mines or pits, may be of great advantage *.

In reſpect to the removal of the water contained in the bottom of ſuch mines or pits, another method of proceeding is recommended; as the level of the ground may probably be no-where lower than that of the opening of the pit. It is ſolely in caſes where the direction of the ſtrata and porous materials have an inclination with the ſurface, or lie horizontally, that ſuch a mode as that which has been juſt deſcribed can be employed with advantage. In inſtances where the direction of them is the contrary of the above, the only chance of

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 78.

removing the water is by difcovering their terminations on the other fide of the elevation, which may in many cafes be in fome meafure afcertained by a careful ufe of the level, and a nice obfervation of the manner in which the ftrata of mine or pit lie. But this will be much better comprehended by confulting the annexed plate.

This is the manner of obviating the effects of water in finking the mines or pits; but a different mode is to be purfued in removing that which is met with in the bottoms of the pits or mines, or which iffues from the rocky ftrata on their fides. Here the aid of machinery of the pump kind becomes neceffary, the operation of which may frequently, as where the ufual ftream is infufficient, be affifted by the water proceeding from the drains that have been juft mentioned, and which is more fully fhewn in the plate. It may alfo be further ufeful in raifing the products from the mines or pits in fituations which are fuitable, and where a full command of it can be had. Another mode of removing water in thefe cafes is, by digging or boring in the bottoms of fuch pits, and thereby letting down the water into the porous materials below where they exift. This is a method that has been practifed with fuccefs in different fituations *.

In raifing ftone from quarries, it not unfrequently happens, that much obftruction and inconvenience is produced by water breaking in when the workmen come to fome depth, from the rocky ftratum in which it has been confined; and which it has been ufual to remove, either by means of expenfive machinery of the pump kind, or very deep and troublefome cuts, made under the level of the water from the neareft fituations that will admit of them. But as in thefe cafes it moftly happens that the water is pent up and confined, both below and on the fides of the rock, by fome impervious material, fuch as clay, fo as to keep it full and prevent its flowing off; it may be more eafily, and with much lefs expence, carried away by cutting a drain through the impervious material that inclofes it on the moft depending fide; which may frequently be difcovered by the nature of the furface-ground and the ufe of the level. This will alfo, at the fame time, have the effect of rendering the ground that is near it dry. And in other cafes of this nature, where the water finks down through the porous or fiffured ftratum of ftone, and is confined by a clofe and compact one below, which has fand and gravel or other porous materials beneath, it may be conveniently removed by boring or digging through the compact ftratum, and thus letting the water down. This method is faid to be particularly advantageous where the termination of the rocky ftratum, which is generally compofed of loofe frag-

* See Agricultural Report of the County of Hertford, p. 67.

ments of ftones of the fame kind, with fand, to fome depth, and of the nature of quickfand, is to be cut through *.

In marle pits alfo, which, from the nature of their fituation, moftly require much cutting through fome part of their fides, in order to remove the water that prevents their being wrought, the mode of letting the water down by means of pits dug through the upholding ftratum below the bed of marle into the porous materials underneath, might be economically practifed. In fuch cafes, the number of the pits muft be proportioned to the fpace occupied by the marle; and when they are required to be of fuch depths as to be liable to give way, they fhould be built up, or nearly filled with loofe ftones, fo as to admit the water to pafs off; fuch lateral drains as are neceffary communicating with them.

In fome fituations of the pits, as where the bank flopes lower on the contrary fide than the level of the water, an eafier mode may be practifed; fuch as by forming a drain in it, and then perforating with a horizontal boring inftrument into the terminating part of the ftratum that holds the water; thereby removing and keeping it below the level of the marle. And in addition to thefe, in fome cafes, as where the water of fuch pits proceeds from fprings in the high grounds above them, it may be ufeful to intercept and convey it away before it reaches the marle-pits.

The principles that have been already mentioned refpecting the nature and direction of the different ftratified materials that conftitute the earth to a confiderable depth below its furface, have likewife another application in the raifing of water in wells; as upon a full and exact comprehenfion of the variation of them, in the different cafes in which attempts of this fort are to be made, muft, in a great meafure, depend the fuccefs of the operator; as has been fufficiently fhewn by the various accounts of finking them in particular fituations, that have been prefented to the public †.

On thefe principles may be explained the reafon, in digging wells, that if ftrata of fand, gravel, or other loofe porous materials be firft met with, water can feldom or ever be found until clay, or fome other impervious fubftance, be reached; or, where clay or other impervious material is begun with, until the the operator has dug down or proceeded to a bed of fome porous fubftance, fuch as rock, fand, or gravel ‡.

They alfo fhew, that by digging wells in particular fituations, in valleys or level grounds, where the water defcends between the ftrata from a diftance at

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 48.

† See Anderfon's Treatife on Draining. ‡ Ibid. p. 69.

a great height, by building up, or otherwife raifing, the top of the well, fo as that it may not give way by the preffure of it;—it may be raifed to a confiderable height above the ordinary level of the well;—and thus, in many cafes, be rendered more ufeful than it could otherwife be. Curious inftances of this nature have been frequently noticed by writers *. And further, that by widening the bottoms of wells in fome cafes, as where the water filtrates between the ftrata in too fparing a quantity, it may be augmented nearly in a fimilar proportion to the extent of the opening †. Practical examples of thefe kinds may likewife be met with in the Philofophical Tranfactions.

As from the ftagnation and retention of too much water, in or upon lands, whether in the ftate of tillage or that of grafs hufbandry, much injury muft be produced;—in the firft cafe, by its rendering the foil too moift and poachy for being ploughed up fufficiently early for many forts of grain crops, and for the manure being properly incorporated and preferved in it; and in the latter, by the cold which it caufes in the winter feafon, rotting, weakening, and thereby rendering the abforbent roots of the graffes incapable of performing their offices; —it is obvious, that the operation of draining muft conftantly be effectually performed, before any other fort of improvement can be attempted with the leaft profpect of fuccefs: until this has been fully accomplifhed, it is indeed impoffible to know whether the land be fuitable for the growth of crops, or what benefits may be produced in it by the application of manures. And, as the removal of fuch degrees of wetnefs as prove detrimental to lands, conftitutes in moft cafes, and efpecially in thofe of the fenny and boggy kinds, an improvement that muft be of great utility and duration ‡, it would feem pro-

* See Johnftone's Account of Elkington's Mode of Draining Land, p. 70.

† See Darwin's Phytologia.

‡ Vaft improvements in the quantity and value of lands have been made by this means in different diftricts. Mr. Young inferts the following Table on the authority of Mr. Parkinfon, as improvements in drainage, by acts in which he was a commiffioner in Lincolnfhire.

	Acres.	Improved value.	Old value.	Improvement.
Tatterfhall embankment - -	892	£. 838	£. 387	£. 450
Alnwick Fen - - - -	1,097	703	54	648
The nine embanked Fens to Lincoln	19,418	15,534	1,941	13,592
Holland Fen eleven towns - -	22,000	25,300	3,600	21,700
	43,407	42,375	5,982	36,390

And

per that the proprietors ſhould, in moſt caſes, be at the principal expence of the buſineſs, as it is ſeldom performed in an effectual manner when undertaken by tenants, unleſs they are unuſually ſpirited, or have ſuch length of leaſes as affords them the certainty of obtaining the full reward of their exertions. When this ſort of improvement is made in the early period of a leaſe, it would, however, be proper in the proprietors to demand a ſuitable intereſt on the ſum advanced, and upon a renewal, to have it added perhaps in the way of rent.

From the whole of the facts and circumſtances that have been mentioned, concerning the nature of the different ſtrata that conſtitute the earth, the directions in which they are depoſited in it, and the manner in which water is carried down, confined, and forced to the ſurface of ſoils, ſo as to become, in different ways and degrees, injurious, it would ſeem evident, that ſprings of ſuch kinds as can be in any material degree detrimental to land, need never be apprehended where there is a great depth of porous materials, ſuch as ſand or gravel, without the intervention of clayey or other impervious ſtrata; or in the contrary ſituation, as where the clayey, marly, or other impervious body, extends to a conſiderable depth. This is a matter that ſhould, therefore, be conſtantly kept in the minds of thoſe engaged in the buſineſs of draining lands. And, that where the miſchief proceeds from ſuperficial wetneſs, cauſed by the ſtiff, retentive nature of the ſoils, there muſt be particular attention paid to the nature

And it is further remarked, that from this view of the drainages in the ſouth-eaſt diſtrict of the county, united with the improvements on the Ancholm, and in Axholm, it will appear that there is not probably a county in the kingdom that has made equal exertions in this very important work of draining. The quantity of land thus added to the kingdom has been great; fens of water, mud, wild fowl, frogs and agues, have been converted to rich paſture and arable, worth from 20*s.* to 40*s.* an acre: health improved, morals corrected, and the community enriched. Theſe, when carried to ſuch an extent, are great works, and reflect the higheſt credit on the good ſenſe and energy of the proprietors. Without going back to very remote periods, it is aſſerted that there cannot have been leſs than 150,000 acres drained and improved, on an average, from 5*s.* an acre to 25*s.*; or a rental created of £.150,000 a-year. But ſuppoſe it only £.100,000, and that the profit has, on an average, been received during the period of thirty years, the rental has in that time amounted to three millions, and the produce to near ten; and that when, with the views of a political arithmetician, we reflect on the circulation that has attended this creation of wealth through induſtry, the number of people ſupported, the conſumption of manufactures, the ſhipping employed, the taxes levied by the ſtate, and all the claſſes of the community benefited, the magnitude and importance of ſuch works will, it is ſaid, be ſeen, and the propriety well underſtood, of giving all imaginable encouragement and facility to their execution.

By means of drainage in boggy and other ſorts of waſte lands that are too wet for the purpoſes of vation in various places, improvements to a very conſiderable extent have alſo been effected; in many inſtances raiſing the value of the land from almoſt nothing to 15*s.* or 20*s.* the acre; as may be ſeen by conſulting the different Reports of the Board of Agriculture.

DRAINAGE OF BOGGY LANDS FROM SPRINGS.

Fig. 1.

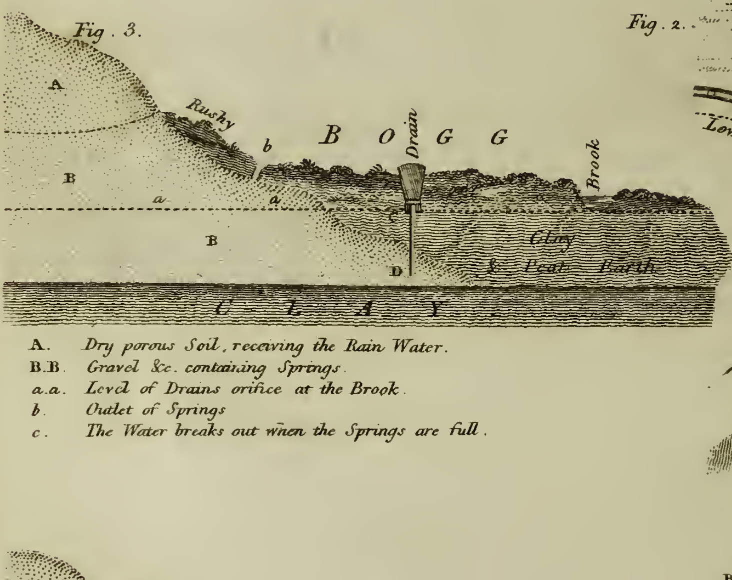


Fig. 3.

A. Dry porous Soil, receiving the Rain Water.
B.B. Gravel &c. containing Springs.
a.a. Level of Drains orifice at the Brook.
b. Outlet of Springs
c. The Water breaks out when the Springs are full.

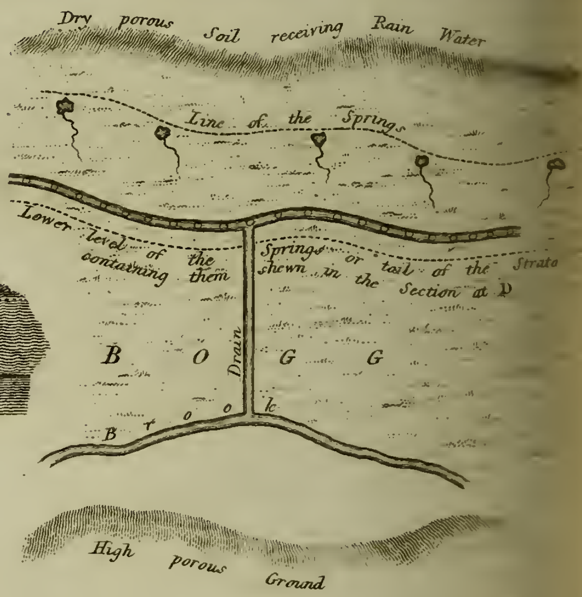


Fig. 2.

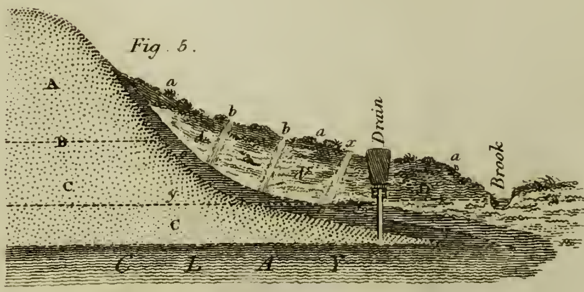


Fig. 5.

A. High porous Ground.
B. Upper level of the Water.
C.C. Gravel &c containing Springs.
D. Outlet.
a.a.a. Boggy Surface.
b.b. Springs.
c.c. Clay
d.d. Peat Earth.
x. Main Spring.
y. Level of the outlet.

Fig. 4.

A.A.A. Springs
D.D.D. Drain cut along the Level of the lower Springs
E. Outlet.

PLATE XXXIX.

Drainage of Boggy Lands from Springs.

[*To face Page* 333.]

Fig. 1. Shows the manner in which the ſtrata of hills or elevated grounds are diſpoſed, and broken or interrupted in their directions to the lower lands or valleys: A, the ſhorteſt method of boring for reaching an inferior ſtratum.

Fig. 2. Explains the method of draining practiſed by Mr. Elkington in the firſt caſe of ſpring bogs, as delineated by Mr. Johnſton.

Fig. 3. Is a ſection of the ſame drainage, when the ſtratum of clay, where the trench is cut, is thicker than the level of the orifice will permit the depth of the drain to be, A being the depth of it at that level. The reſt of the clay, from A to B, is to be perforated by an auger to the lower point of the porous ſtratum at D, when the water will riſe up in the trench from the preſſure above the level of the drain.

Fig. 4. Repreſents the mode of drainage in the ſecond caſe of ſpring bogs on Mr. Elkington's principles, as explained by Mr. Johnſton.

Fig. 5. Is a view or ſection of the ſame.

Fig. 1.

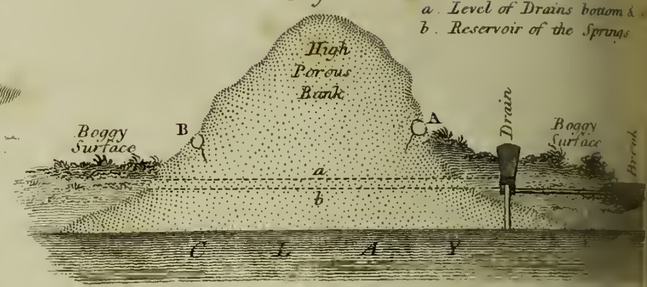


Fig. 2.

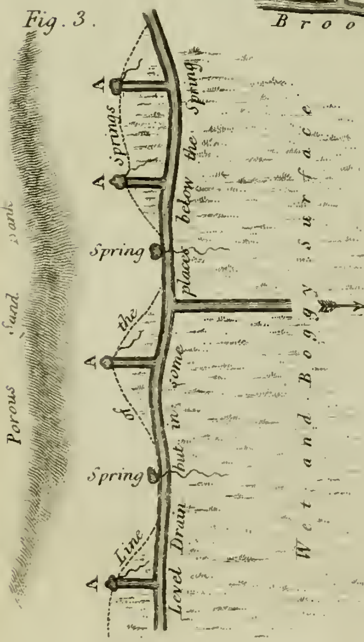


Fig. 3.

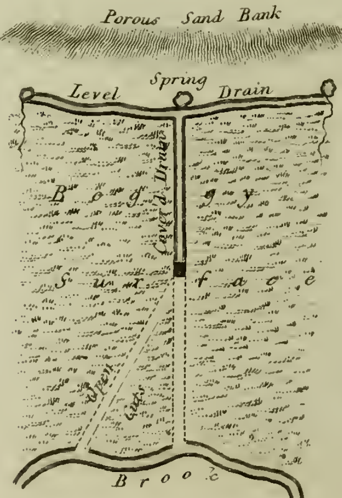


Fig. 4.

Fig. 5.

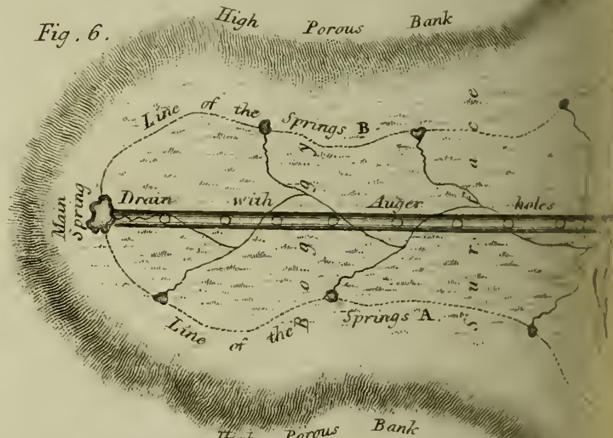


Fig. 6.

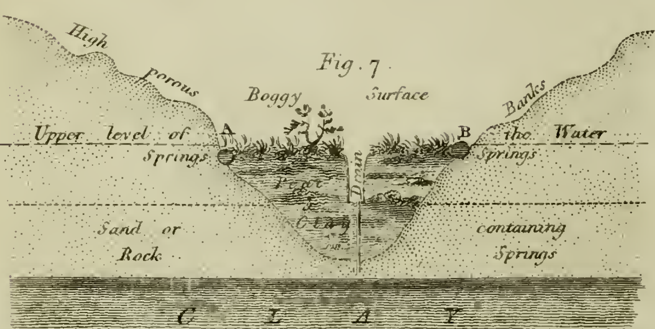


Fig. 7.

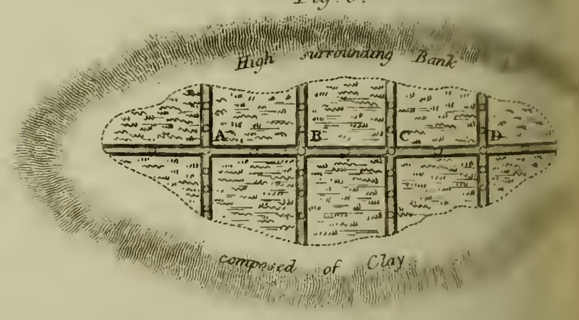


Fig. 8.

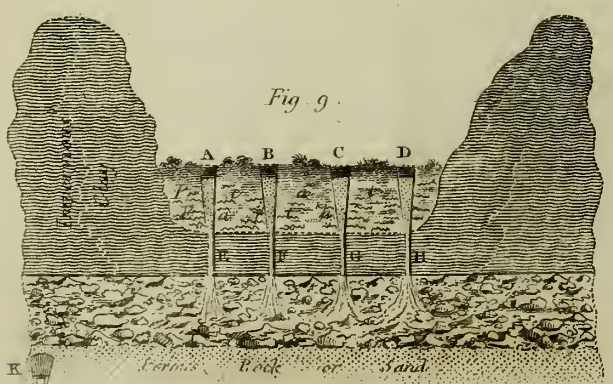


Fig. 9.

PLATE XL.

Drainage of Boggy and Wet Lands.

[*To face Page* 332.]

Fig. 1. reprefents the plan of draining purfued by Mr. Elkington in hilly fituations, or where there are high banks, with wet grounds below.

Fig. 2. Is a view or fection of this drainage, as given by Mr. Johnftone.

Fig. 3. Is the reprefentation of the plan of draining where the banks are irregular.

Fig. 4. Shows the manner of cutting and managing the drains in this cafe. And

Fig. 5. Is a fide view or fection of the fandy bank.

Fig. 6. Explains the method of draining of bogs where the fand-banks unite. Where the bog has a defcent from the fide A A to the fide B B, a drain cut on the fide A A may be fufficient for the purpofe.

Fig. 7. Is a front view of this drainage.

Fig. 8. Exhibits the plan of another method of drainage, recommended by Mr. Elkington, in boggy or fpots of marfhy land injured by ftagnant moifture, but where fprings do not exift. This is by letting the water down into the porous fubftratum below by perforating through the retentive body above.

Fig. 9. A front view or fection of this drainage: A B C D here, as in the plan, reprefents the drains cut through the boggy earth, and filled up to within a foot and half of the top with loofe ftones.

E F G H fhows the perforations of the auger through the clayey ftratum, and the defcent of the water into the rocky or porous ftratum below.

K, the place where a cut fhould be made for draining off the water where the land declines fufficiently, and the porous fubftratum is faturated with it fo as to throw it on the furface through the perforations.

5

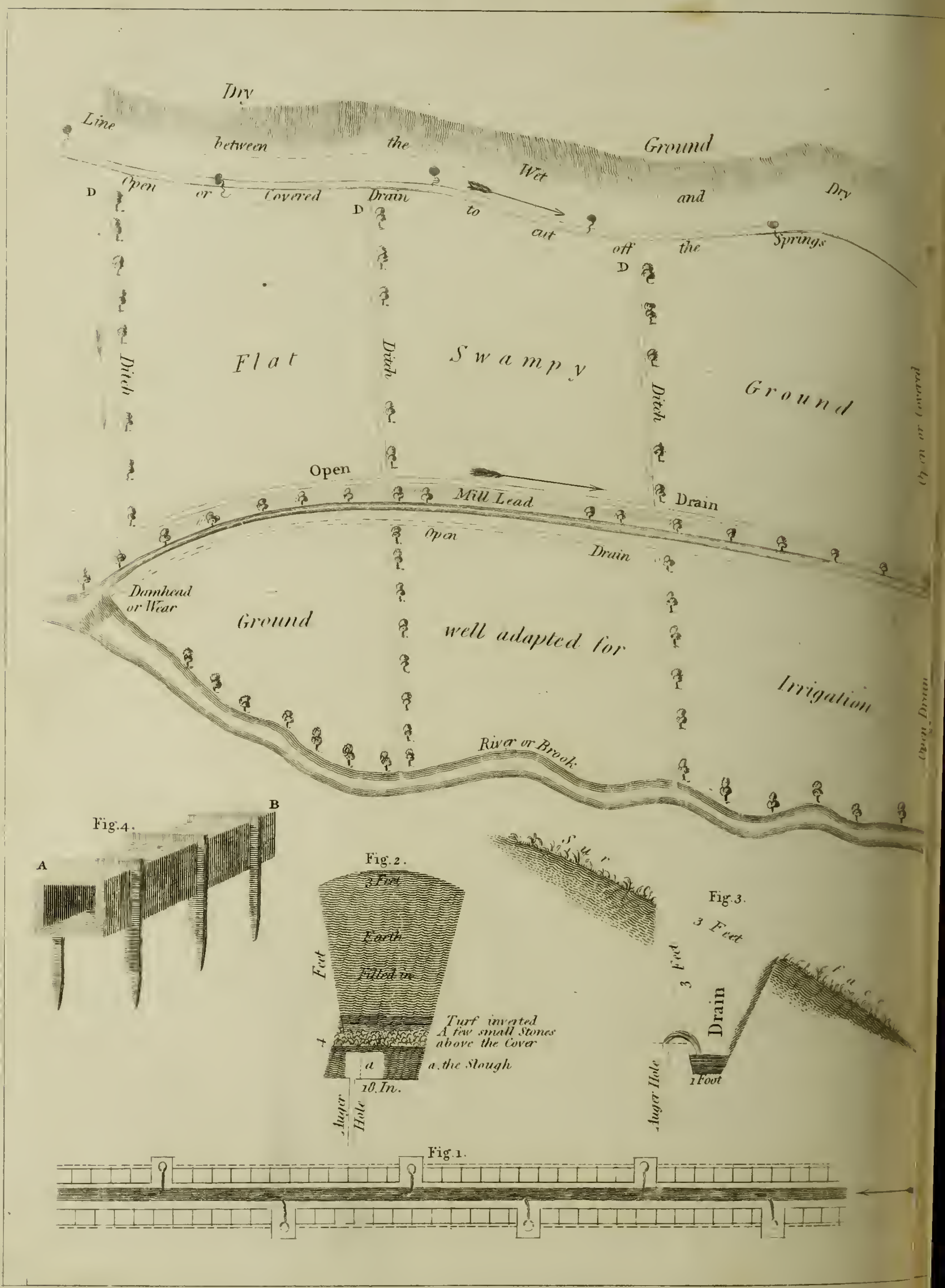

Dry
Line between the Wet and Dry Ground
Open or Covered Drain to cut off the Springs
D
D
D
Ditch
Ditch
Ditch
Flat Swampy Ground
Open Mill Lead Drain
Open Drain
Damhead or Wear
Ground well adapted for Irrigation
River or Brook
Open or Covered
Open Drain
Fig. 4.
A
B
Fig. 2.
3 Feet
Earth
Filled in
Feet
4
Turf inverted
A few small Stones above the Cover
a
a. the Slough
10. In.
Auger Hole
Fig. 3.
Sur face
3 Feet
3 Feet
Drain
Auger Hole
1 Foot
Fig. 1.

PLATE XLI.

Draining of low ſwampy Lands.

[*To face Page* 333.]

Fig. 1. Shows the manner of digging into the ſides of the drains, where ſoughs are laid in running ſands, and the auger employed, as the holes in this way are leſs interrupted by the currents.

Fig. 2. Is a ſection, ſhowing the manner of laying the ſough and covering it.

Fig. 3. Shows the manner of forming the auger holes ſo as to be higher than the bottom of the drains, in hilly ſituations.

In the plate a plan is given of Mr. Elkington's method of accompliſhing the purpoſe of draining in low ſwampy lands on the ſides of rivers, in which the advantages that may be gained, in ſome caſes, by irrigation are likewiſe ſhown.

Fig. 4. Shows the manner of draining where the water is dammed up as a mill-head, being a trough ſeveral feet longer than the width of the dam on each ſide, as ſeen by A and B in the plan. It is ſecured by ſtakes driven into the earth on each ſide with croſs bars above, as repreſented in the figure. The ſpace between the top of it and bottom of head is to be well rammed with clay. A cut is alſo neceſſary, on bank of head, for ſecuring water.

DRAINAGE OF HILLY LANDS & MIXED SOILS.

Fig. 2.

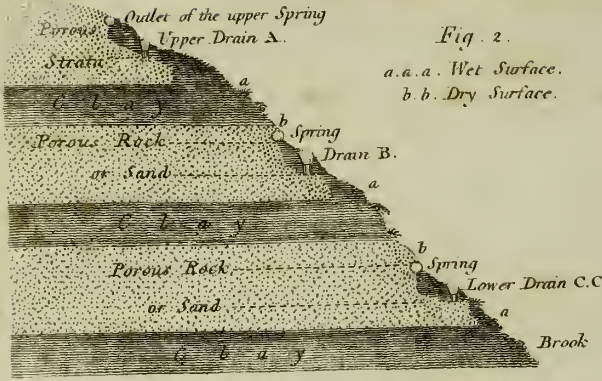


Fig. 3.

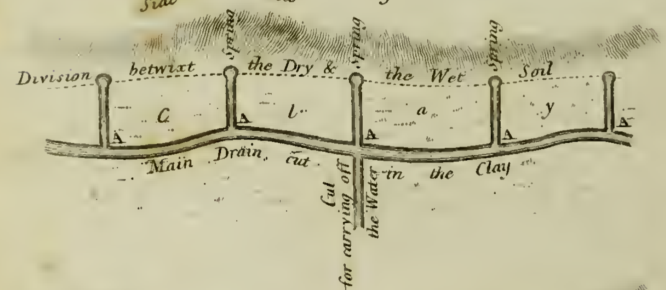


Fig. 4

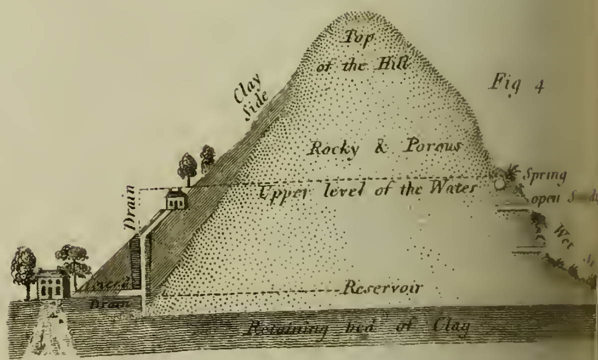


Fig. 5.

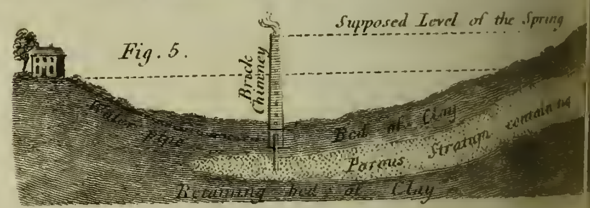


Fig. 7.

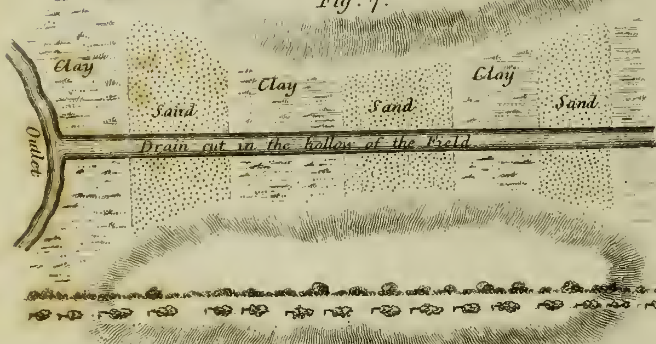


Fig. 6.

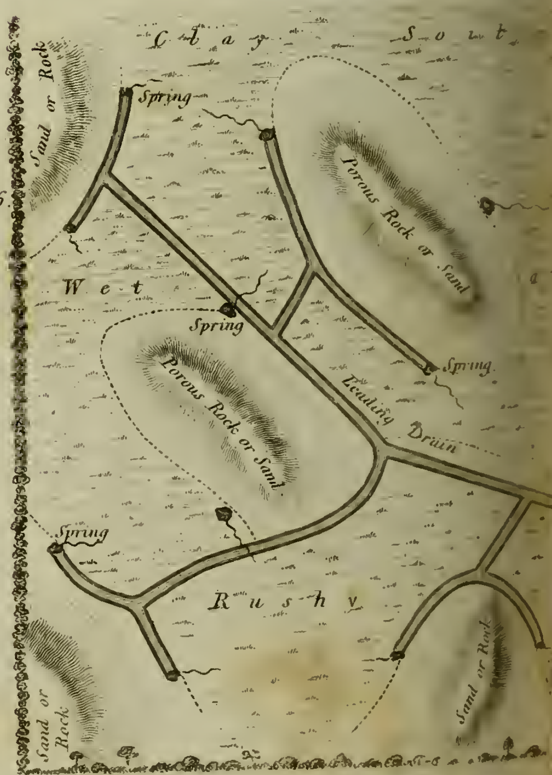


Fig. 8.

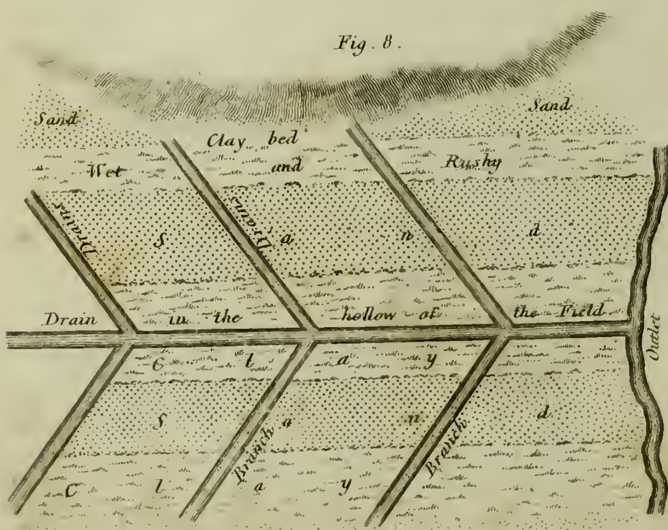


PLATE XLII.

Drainage of Hilly Lands and Mixed Soils.

[*To face Page* 333.]

Fig. 1. Reprefents the plan of Mr. Elkington's method of draining in a hill compofed of alternate beds of rock and clay.

Fig. 2. Is a fide view or fection of the fame, which explains the fituation of the ftrata and the places for cutting the drains.

Fig. 3. Shows the nature of the drains; the main drain to be formed wholly in the clay, and drains cut into each of the fiffures between the rocks when the water is contained there: A A A A A, points in the main drain, where attempts may be made to effectually intercept the water iffuing along the dotted line above it by boring, inftead of its being reduced by the fmall cuts, fo as to produce no injury on the furface of the land below.

Fig. 4. Is a view or fection of the hill to be drained, and the mode in which water may, from the irregularity of the retentive ftrata, be drawn off on the dry fide for domeftic ufes.

Fig. 5. Reprefents the mode of raifing the water to the level of the head of the refervoir in low fituations, by confining it in a narrow pipe or chimney of brick.

At *Fig.* 6. is reprefented Mr. Elkington's method of drainage in cafes where the foils are compofed of alternate beds of clay and fand. The form of cutting, fo as to remove the wetnefs from the different refervoirs, is fully fhown. In fome cafes this wetness may proceed from fprings higher up, and paffing over the upper foil through the fand beds, by not being permitted to defcend lower than the retentive bed of clay. In thefe fituations the drainage may be effected with facility, after a conducting main drain from the outlet has been formed, by making an upper drain to intercept the water coming from the chief fprings, as explained by Mr. Johnfton in the new edition of his account of the mode of draining land.

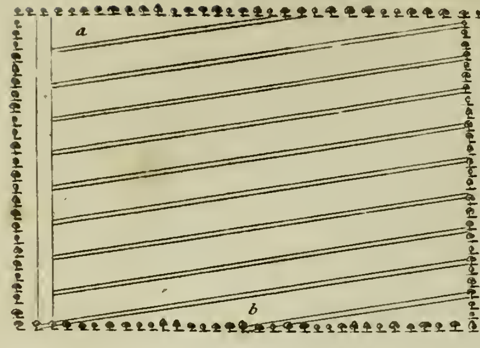
Fig. 7. Shows the method of draining in other cafes of this fort, as where the land or field is hollow, and only requires one principal drain to be cut towards the middle.

Fig. 8. Explains other cafes of this nature, where, from the diftribution of the ftrata, other drains become neceffary, in a floping direction acrofs the declivities.

DRAINAGE of LANDS

where the soils are porous above and retentive below.

Fig. 6.



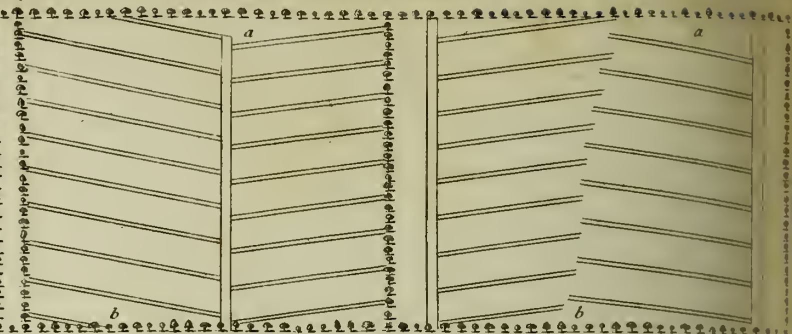


Fig. 7.

Fig. 1.

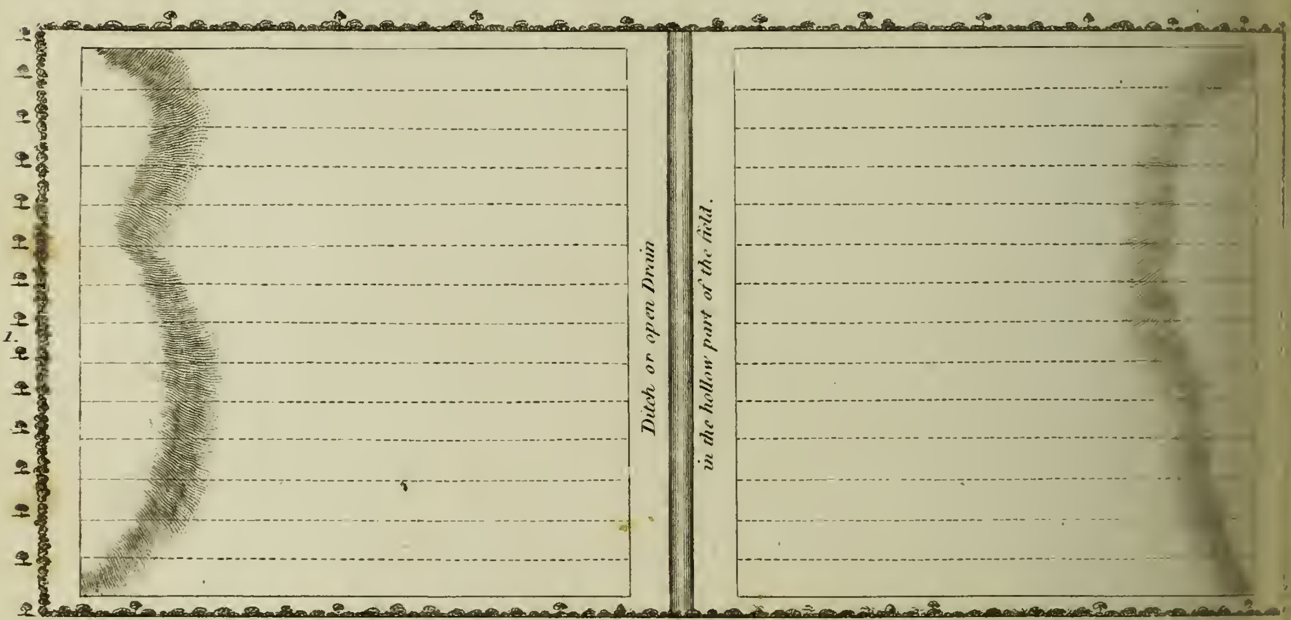


Fig. 2.

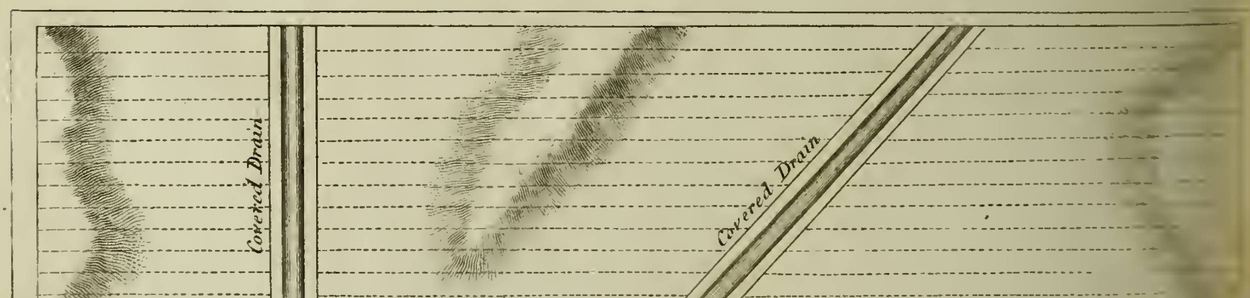
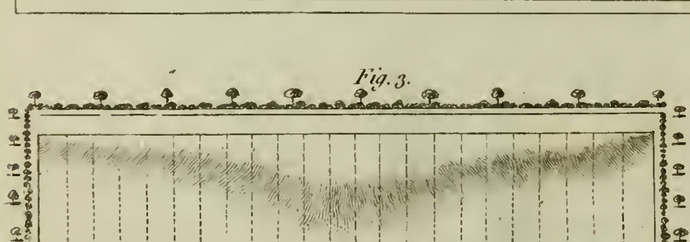


Fig. 3.



Ditch or open Drain.

Fig. 4.

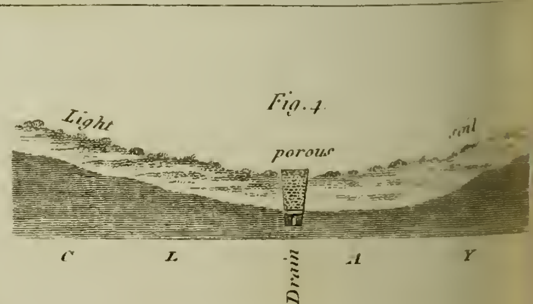


PLATE XLIII.

Drainage of Lands porous above, and retentive below.

[*To face Page* 332.]

Fig. 1. Represents the plan of draining followed by Mr. Elkington, where the foil is porous on the furface and retentive underneath, and where the ground declines towards the midddle where the drain is made, the ridges being formed fo as to anfwer the declivity.

Figs. 2 *and* 3. Explain the method of forming the drains where the grounds have more than one depreffion, or are nearly level, or incline a little to one fide.

Fig. 4. Is a view or fection of the above.

Fig. 5. The Effex method of draining in ploughed fpringy lands, where the furface foil is tenacious, as defcribed by Mr. Kent. Main declination of the land from *a* to *b*.

Fig. 6. Reprefents a field drained by means of one of its ditches in the room of a chief drain.

Fig. 7. A field drained by a principal drain in the middle, declining more at that part than the fides.

Fig. 8. A field drained by two outfide principal drains, the land being higher in the middle than on the fides.

Pl. XLIV

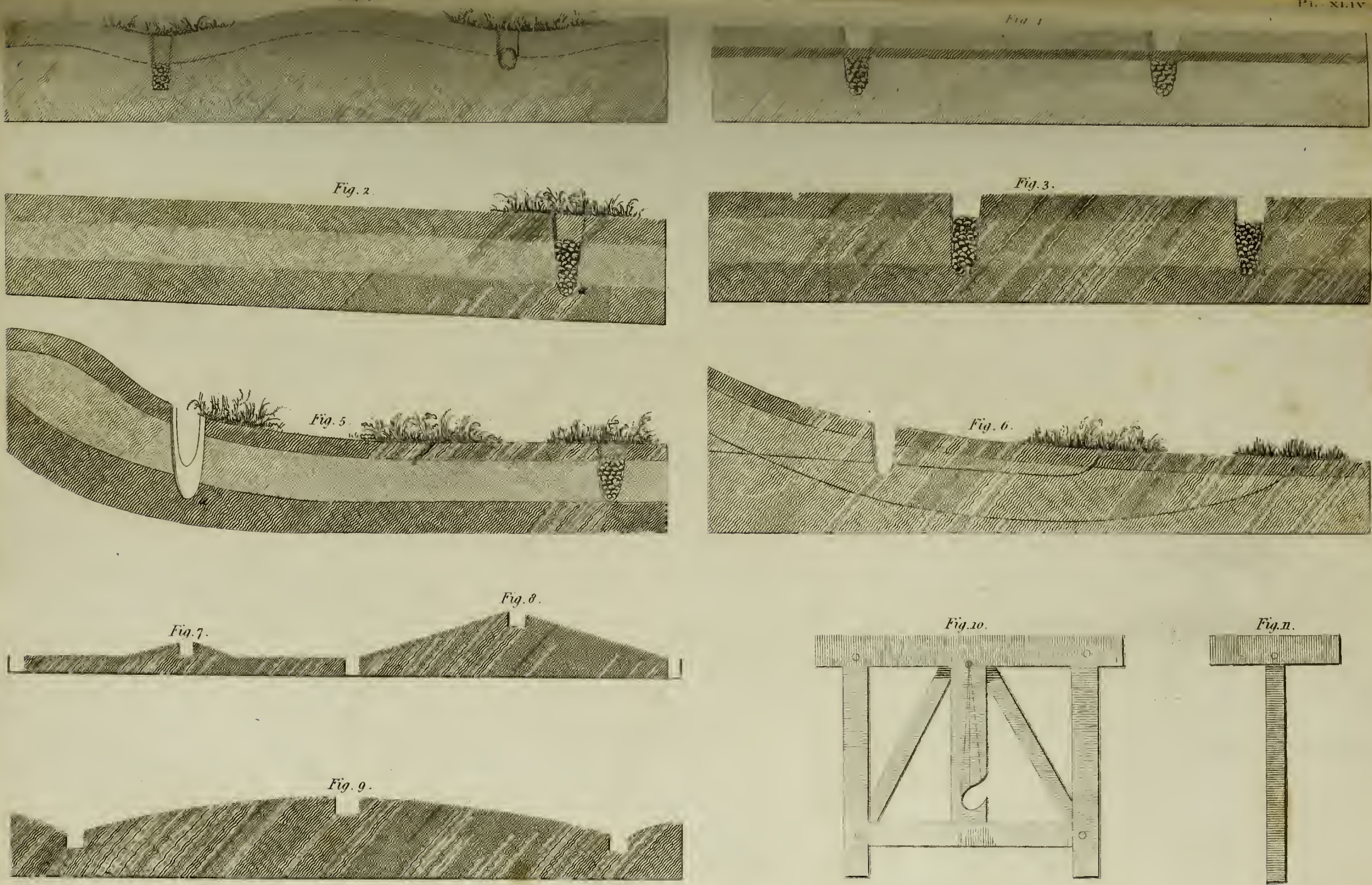


PLATE XLIV.

Drainage in various Kinds of Soil.

[*To face Page* 332.]

Fig. 1. Reprefents a mode of draining where the furface, fubfoil and bafe of the foil are impervious, and where the ridges are improper to be levelled down by fubdrains in the furrows between them.

Fig. 2. Shows a manner of draining where the furface foil and bafe are repellent, and the fubfoil porous or abforbent, by fidelong drains where the land has much declivity, formed in the parts where the wetnefs is predominant, as at *a*, down to the under ftratum and a little into it.

Fig. 3. Exhibits a method of draining where the furface is impervious, the fubfoil abforbent and clofed, and the bafe impervious or abforbent and clofed, by drains formed according to circumftances in a fimilar manner to thofe in *Fig.* 2. In this cafe they will feldom be required to be fo near to each other as in the former cafe.

Fig. 4. Explains a mode of draining where the furface and fubfoil are abforbent and clofed, and the bafe either impervious or abforbent and clofed, by cutting drains through the fubftrata, forming a firm bafe for the bottoms of them when neceffary with tough turf, heath or bufhes, performing the work in a dry feafon.

Fig. 5. Reprefents a mode of draining where the furface foil is impervious or abforbent, the fubfoil porous and clofed, being conftantly charged with wetnefs from internal defcending water by means of a gravelly conductor, the bafe being impervious by the cutting of only one drain acrofs, at the lower part of the flope, as at *a*, where the fubfoil is fufficiently porous.

Fig. 6. Explains a method of draining where the furface foil is porous or impervious, the fubfoil abforbent or varied, being charged with water from above in a partial manner, through veins, or fand, gravel, or fiffured rock, by means of covered drains made to decline in an eafy manner, from the affected part to a common drain.

Thefe modes are recommended by Mr. Marfhall.

Fig. 7. Is a tranfverfe fection of a ridge on a flat furface for watering in the firft year of its formation, ufed in Gloucefterfhire.

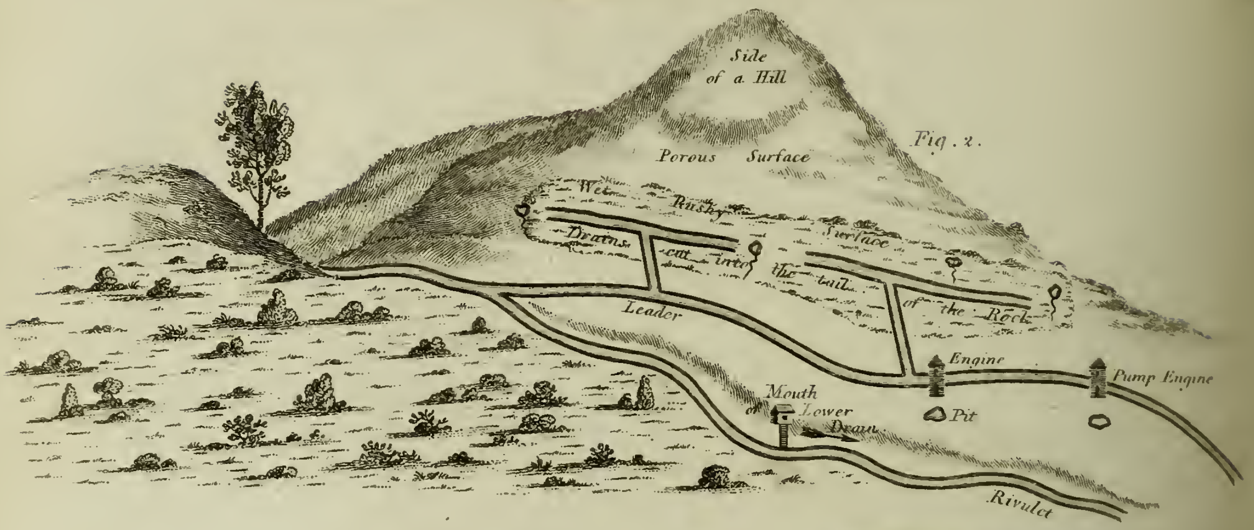
Fig. 8. Shows a ridge in its full elevation with its fides being perfectly inclined planes, having the proper fall of two inches in each yard.

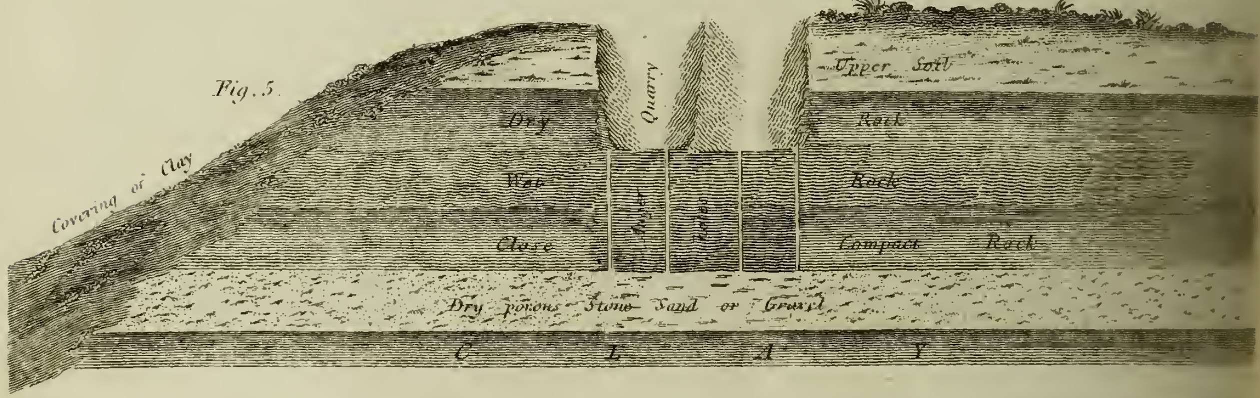
Fig. 9. Explains the form of a ridge for trying the effects of watering in flat land.

Fig. 10. Is a levelling implement recommended by Mr. Marfhall, as very ufeful in fetting out water-courfes, fo as to give every part an equal and uniform degree of defcent. It fhould be made five feet and a half long, and in height from four to four feet and a half, according to the height of the perfon to employ it.

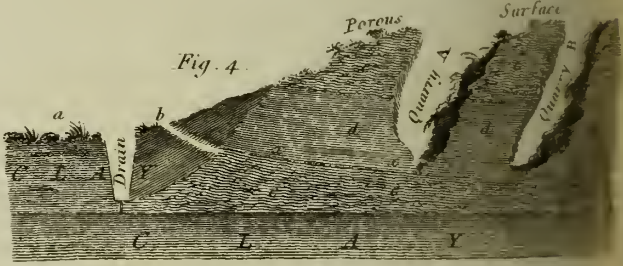
Fig. 11. Is the object ftaff: the crofs piece fhould be painted white. The whole fhould be made of a good fize, and exactly as high as the level.

DRAINAGE OF MINES, QUARRIES & PITS.





a.a.a. Springs or Outlets of part of the Water.
b.b.b. Drain along the tail of the Rock.
c. Drain for carrying off the Water.



a. Wet Rushy Surface.
b. Outlet of the Water.
c.c. Upper Soil.
d.d.d. Dry Rock.
e.e. Wet Rock.
x.x. Upper Level of the Water.

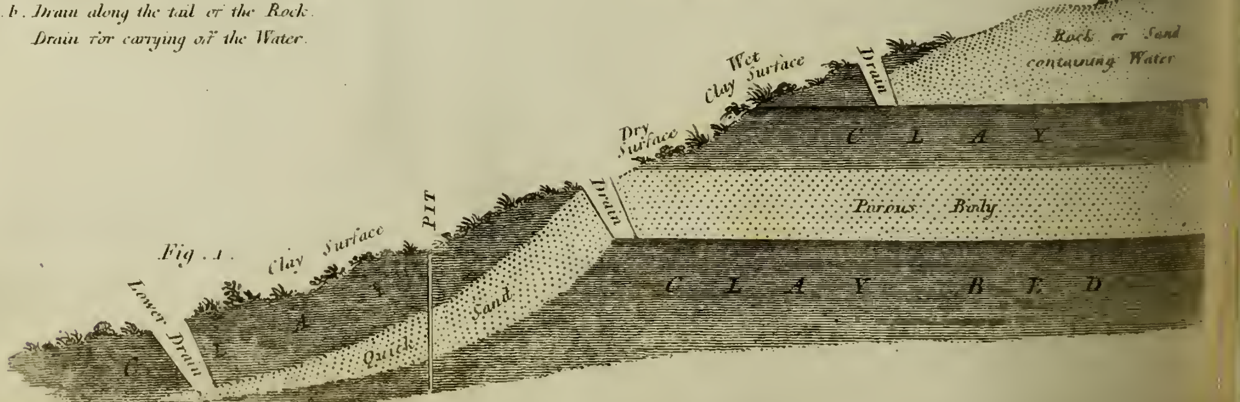


PLATE XLV.

Drainage of Mines, Quarries, &c.

[*To face Page* 333.]

Fig. 1. Reprefents a view or fection of the drainage of a mine, as practifed by Mr. Elkington, explaining the manner of cutting off the water in finking the fhaft, &c.

Fig. 2. Is the plan and manner of forming the drainage.

Fig. 3. Explains the mode of cutting the drains through the clayey ftratum covering the rocks, fo as to difcharge the water there pent up by it.

Fig. 4. Is a view or fection of this drainage.

Fig. 5. Reprefents the method of letting the water down into the porous ftratum below, by digging pits or boring through the impervious body by an auger. In fome cafes another porous ftratum may be difcovered by boring below the fecond retentive one, and the water be thereby reduced to a ftill lower level.

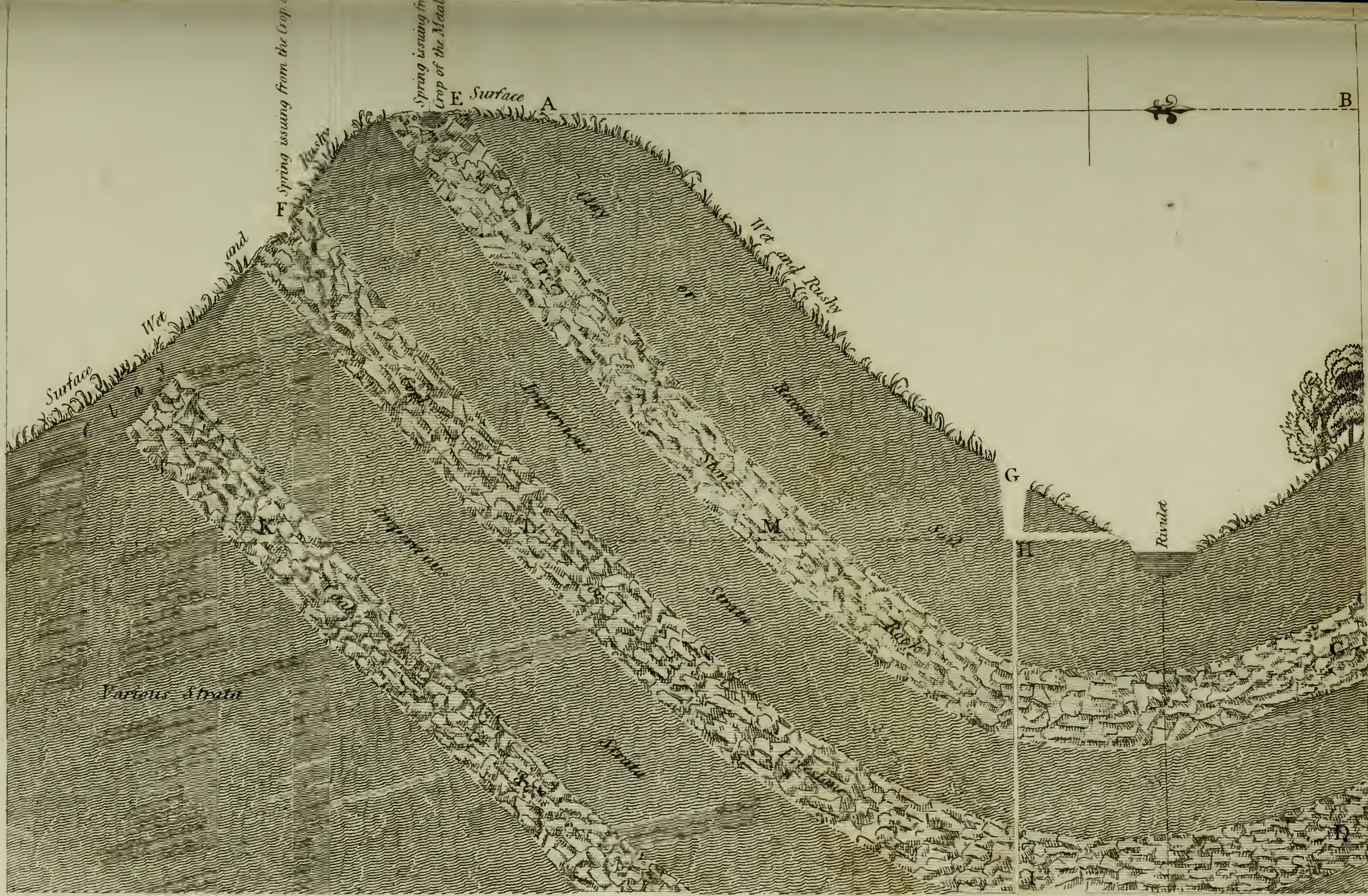

Surface
Wet
and
F
Spring issuing from the Crop &
Rushy
Spring issuing fr
Crop of the Metal
E
Surface
A
B
Wet and Rushy
G
H
Rivulet
K
L
M
C
D
Various Strata
Impervious
Strata

PLATE XLVI.

Drainage of Wetneſs cauſed by Mineral Strata.

[*To face Page* 332.]

Fig. 1. Shows the plan of draining wetneſſes on the tops of hills and banks, contiguous to low grounds, but ſupplied from high lands at ſome diſtance by means of metallic ſubſtrata. The ſtrata C D continue on ſome riſe in high ground north of rivulet to higher level than line A B, by which ſprings, E and F, from the *crop* of the metals, are ſupplied. An outlet will be obtained by a cut from a rivulet to bank G free of the former, and by boring or ſinking: pit from H to I the water paſſing through porous ſtrata from C D to E F will be reduced to the level L M; of courſe, the ſource of ſprings E F be cut off, and ground on top and ſides of hill become dry; and metals to that depth wrought without inconvenience from water, which could not be done by boring in bottom of rivulet, as ſhown by dotted line. When ſtrata K crop out to ſurface and produce wetneſs, the pit or bore H I may be continued till it reach it when neceſſary. This is a method deſcribed by Mr. Johnſtone, in his account of Mr. Elkington's mode of draining.

Mr. LUMBERT'S MOLE PLOUGH.

PLATE XLVII.

Mr. Lumbert's Mole-Plough.

[*To face Page* 332.]

In the Plate are given reprefentations of the plough, and the windlaffes by which it is drawn: in which *Fig.* 1. is the beam. 2. the mole, to which fegments for lengthening it fcrew on at 3. 4. the roller at the heel on which it preffes. 5. the chain, from 50 to 60 yards long, which winds on to the two cylinders, 7, 7. 6, a pulley, round which the chain 5. plays. 8, 8, 8, 8. Windlaffes, turned each by two women. 9. Stays which, entering the ground, affift in keeping the machine fteady. 10. the anchor.

The proportion and refpective angles of the different parts of the implement may be found by the fcale. It is wrought by eight women; and Mr. Lumbert contracts for the work at $1\frac{1}{2}$*d.* the perch, lug, or rod of $5\frac{1}{2}$ yards, his foreman agreeing with him for doing it at three farthings, the machine being found, who pays himfelf and the women out of it. It performs from 150 to 200 perches a day; and 300 have been done. 200, at three farthings the perch, amounts to 12*s.* 6*d.* a day; the eight women, at 8*d.* each, amounts to 5*s.* 4*d.*, leaving 7*s.* 2*d.* for the foreman's pay, and the repairing of the chain, which breaks often, and wants a falfe link whenever that happens. It was found to move, on an average, 5 yards in a minute; but much time is taken up by moving the windlafs, frame, and anchor.

The inventor goes to any part of the kingdom with the machine, at $1\frac{1}{2}$*d.* the rod; but when to a diftance, muft have infured work in the proportion of 200 rods for every mile out. He fells the tool for 50 guineas, as he has a patent. It ufually goes 17 or 18 inches deep, but can go deeper; and has been found a very effective tool on clayey foils, the drains continuing to run after many years.

Mr. Young has given a particular account of this valuable draining-plough, and fuggefted various applications of the windlaffes, which may be feen in the forty-fecond volume of the Annals of Agriculture, page 413.

SECTIONS of covered DRAINS, & draining Implements.

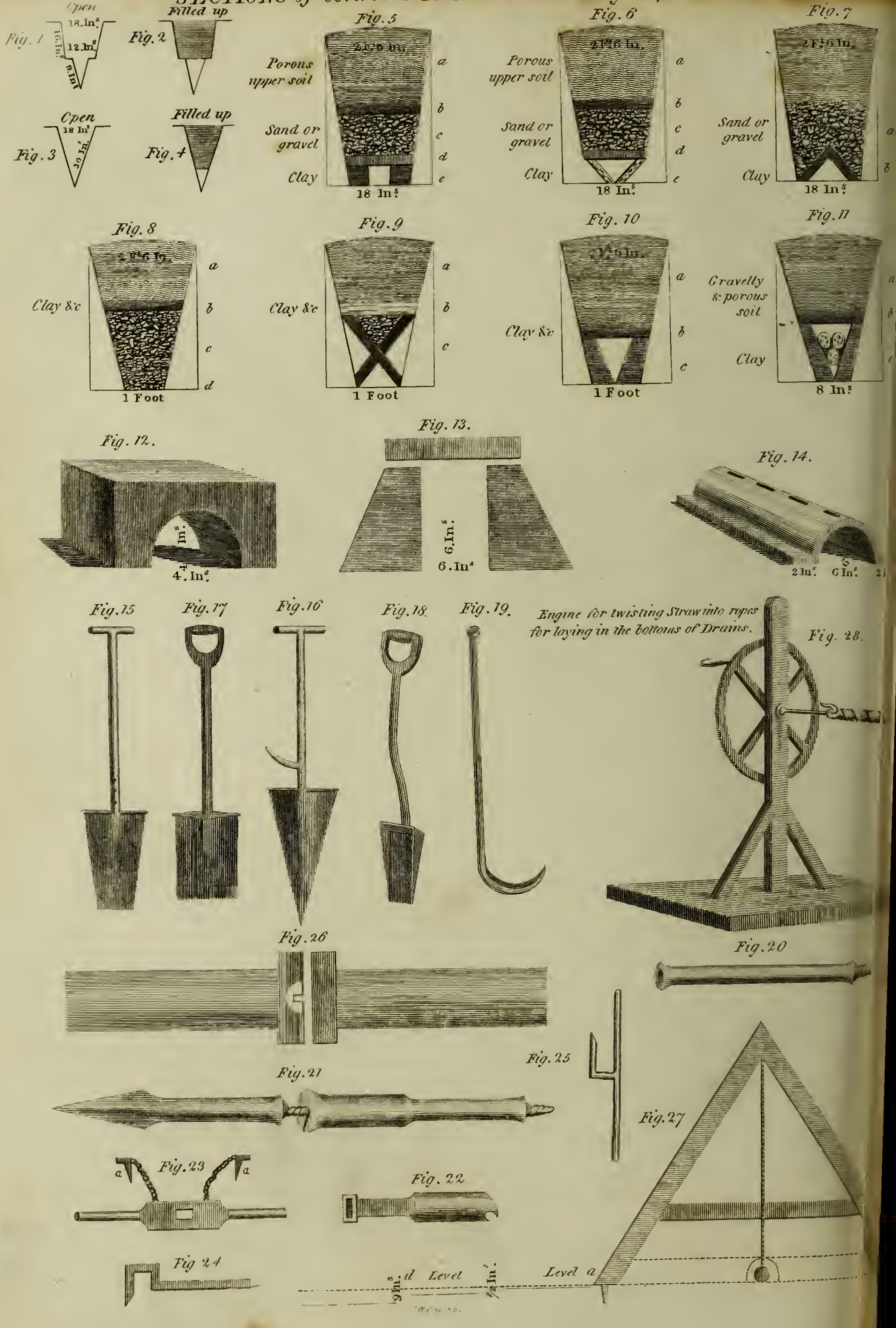


PLATE XLVIII.

Sections of Covered Drains and Draining Implements.

[*To face Page* 332.]

Fig. 1. Reprefents a *fhouldered turf-drain*; the inverted turf refting here more firmly on the fhoulders than in the common method without them, leaving the part hollow below.

Fig. 2. Shows it filled up.

Fig. 3. Reprefents the *wedge-form* of drain, a part of the bottom of the wedge part being removed before it is put in again.

Fig. 4. Shows it when filled up.

Fig. 5. The fection of a hollow drain: *a* loofe mould thrown in to the depth of one foot; *b* fod inverted two inches thick; *c* round land ftones one foot thick; *d* flat ftone or cover four inches thick; *e* fough or conduit fix inches fquare lined with ftone.

Fig. 6. Another fection: *a* loofe mould as above; *b* thin fod inverted, ftraw, heath or rufhes; *c* round land ftones or faggots of brufh-wood; *d* flat ftone or cover four inches thick; *e* triangular opening fix or eight inches.

Fig. 7. A fection of drain: *a* land ftones as before; *b* triangular or coupled opening, fix or eight inches.

Fig. 8. Section of hollow drain: *a* loofe mould or gravel thrown in one foot; *b* fod, ftraw, heath, or rufhes, four inches; *c* land ftones thrown in; *d* one foot eight inches thick.

Fig. 9. Section of covered drain: *a* loofe mould thrown in one foot; *b* ftraw, &c., fix inches in thicknefs; *c* brufhwood laid longitudinally and fufpended by crofs billets of wood, having bottom and fides to the height of crofs billets open one foot fix inches.

Fig. 10. Another fection of hollow drain: *a* loofe mould or gravel one foot; *b* fod inverted fix inches; *c* pipe or opening formed by draining-fpade, one foot deep and eight wide at fhoulders.

Fig. 11. Section of covered drain: *a* drain one foot deep; *b* clay trampled in fix inches; *c* pipe or opening formed by draining-fpade one foot deep, and filled with three large ftraw ropes, laid lengthways.

Fig. 12. Reprefents a *draining-brick* chiefly ufed for fmall drains, as conveying water to houfes, and

Fig. 13. Shows another fort of *draining-brick* for conftructing a large fquare drain laid without common brick.

Fig. 14. Exhibits another form of *draining-brick* for forming larger forts of drains.

Fig. 15. Upper draining-fpade.

Fig. 16. Lower draining-fpade pointed at the bottom.

Fig. 17. Wooden fpade for peaty foils.

Fig. 18. Bottom fhovel with turned-up edges.

Fig. 19. Scoop for cleaning out and fmoothing out bottom of drains.

Fig. 20. The rod fcrew for the auger four feet.

Fig. 21. Chifel and punch for cutting ftones.

Fig. 22. The auger.

Fig. 23. Wooden handle with iron plates on both fides to ftrengthen holes for rods; *a a* wedges.

Fig. 24. Iron key.

Fig. 25. Iron handle.

Fig. 26. Boards ufed in boring with the auger.

Fig. 27. An inftrument for levelling drains, water-courfes, &c.: *a b* the fides of the frame; *c d* a line marked off.

Fig. 28. Is an improved machine for twifting ftraw into ropes.

DRAINING BRICKS.

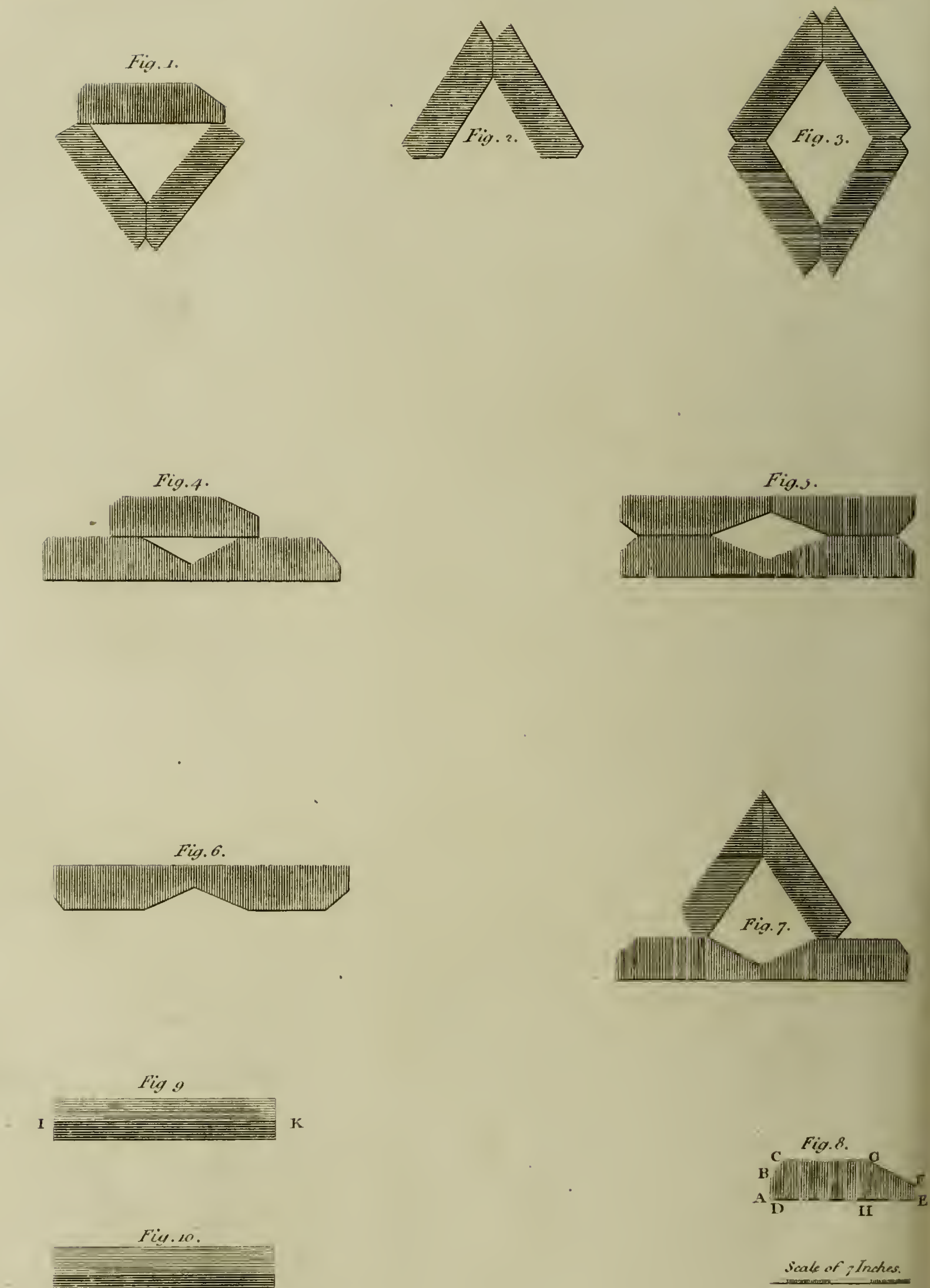


PLATE XLIX.

Draining-Bricks.

[*To face Page* 332.]

Fig. 1. REPRESENTS the form and manner of placing bricks, invented by Mr. Aſhworth of Turton, near Bolton, in Lancaſhire, in the draining of land, in which 84 bricks are required to every eight yards, while with common bricks 192 are neceſſary; of courſe there is a ſaving of 108 in this way in every eight yards of draining.

Fig. 2. Is another form of brick, in which 55 bricks are ſufficient for draining eight yards in length; by which 137 bricks are ſaved in that diſtance.

Fig. 3. Is a form which takes 110 bricks to complete a drain of the ſame length; by which 82 bricks are ſaved. This form is only neceſſary where much water is to be conveyed away.

Fig. 4. Is another form which employs and ſaves bricks in the ſame proportions as *fig.* 1.

Fig. 5. Is another form of brick that employs and ſaves in the proportions of *fig.* 3. It is particularly uſeful in draining boggy ſoft lands, and where there are quickſands.

Fig. 6. Is another form that ſaves bricks as in *fig.* 2.

Fig. 7. Another form that takes the ſame as in *figs.* 3 and 5.

Fig. 8. Is a croſs ſection of one of the bricks 7 inches broad and 2 in thickneſs. The perpendicular line from A to B is 1 inch; the ſlope from B to C 1¼ inch; the diſtance from A to D by a perpendicular line from C is full ½ inch. The perpendicular line from E to F is ¾ of an inch; the ſlope from F to G full 2¼ inches; the diſtance from E to H by perpendicular line from G is 2 inches.

Fig. 9. A full length view of the brick, exhibiting the narroweſt ſlope. It is 10 inches from I to K.

Fig. 10. Is another whole length view of the ſame brick the contrary way, preſenting the broadeſt ſlope.

and pofition of the land, the direction, cutting, and mode of filling the fuperficial hollow drains employed in fuch cafes; and, at the fame time, to the ridging and furrow draining, as well as the loofening of the foil to a good depth, when in a ftate of arable cultivation; as upon a due execution and combination of thefe, the fuccefs of the drainer muft greatly depend.

From the great variety that exifts in the nature of the ground to be drained, it will alfo always be of the utmoft confequence to afcertain, with accuracy, from what fource or caufe any wetnefs of land, which is to be removed, arifes, before the bufinefs of draining is begun; as without a confiderable degree of caution in this refpect, many unneceffary drains may frequently be cut, and much money expended without advantage; as the work muft be managed very differently in cafes where it proceeds from furface-water merely, and thofe in which it depends upon the dribbling of land, or other fprings.

SECTION IX.

Paring and Burning.

Paring and Burning—Practice of, adopted at an early Period—A Process in which various Changes are produced in Soils—Some of which probably lessen Fertility—Others greatly promote it—Consumption of vegetable and animal Matters prejudicial—The Conversion of the fresh vegetable Products into saline Matters highly beneficial—Combination of Oxygen with the Soil of great Utility---The saline Matters seem to be the Cause of the great Luxuriance of Crops after—Must tend to exhaust the Land—Great stimulant Power of, useful in promoting Vegetation—Manner in which Lime may be useful when used with the Ashes—Injury only done by the Loss of vegetable or animal Matters—The earthy Matter not capable of being lessened by—Frequently left in a more pulverizable State—Loss of vegetable Matter probably not so much as supposed by some Writers—Ashes produced in the Process shewn to be highly useful—Nature of the saline Substances—Fixed Alkali and vitriolated Tartar, both useful for the Purpose of Vegetation—Other Modes in which the Process may be useful in promoting the Growth of Crops—By the Reduction of all Sorts of coarse vegetable Materials—Rendering them more readily acted upon by other Substances in the Soils---By preventing the Land in this Way from becoming too open and light for Grain-crops—By the Earth, in many Cases, being rendered more mellow and fine, and thereby more suitable for the Reception of the Roots of growing Plants—By the complete Destruction of Weeds, in some Instances, the Lands are more at liberty to support the cultivated Crops.—The Practice probably more adapted to some Sorts of Lands than others—Least useful on the thin, light Soils, or such as have been in Tillage—Most advantageous on the stiff, heavy, coarse, and sour Soils; or such waste Lands as are infested with coarse Productions of any Kind—This supported by the general Experience of Agricultors—The Reason of, explained—The Opinion of an able Writer upon—On mossy or peaty Soils must be practised with great Caution—Improper for the Operation in some Cases—Dr. Anderson's Opinion against the Practice on—A Fact respecting, in other Sorts of Land—Improper Management probably the Cause of—May however sometimes be employed on them—More Caution necessary than in other Soils—The Practice general on the coarse, waste, heavy Sorts of Soil—Utility and Advantages of, acknowledged by most Writers on Agriculture—Mr. Middleton's Opinion of in breaking up Land—Those of others stated—Causes of Objection to the Practice of Paring and Burning—Origin of—No Loss of Soil in, but from the vegetable or elastic Matters—This not so great as supposed—Clayey Soils supposed by some to be most liable to Injury from improper Management of—By others supposed useful in mellowing the Soil—Mr. Young's Opinion of the Objections made to, in Fen Districts—Facts shew little Danger to exist when properly performed—Differences in the Method

of performing the Operations—Probably neceſſary from the Differences of Soil—Manner of proceeding moſt uſeful in different Caſes—Implements employed in the performing of, different—Advantages of each—Hand Tools in general moſt effectual—Ploughs moſt expeditious when they can be uſed—Seaſon for the Proceſs—Dry Weather highly neceſſary—Spring Months generally the beſt—Muſt vary from the Nature of Crops—For Rape and Turnips—For Barley—For Wheat—Thickneſs of Parings ſhould depend on the Nature of the Soil—Mr. Boys' Opinion of—Uſual Depths of—Circumſtances to be regarded in ſpreading the Aſhes—Particular Mode of, in ſome Places—Objections to—Expences of, in lighter Sorts of Soils—In Fen Diſtricts—Manure produced by—Moſt advantageous Methods of cropping after the Proceſs in different Caſes—Eſtimates of the Expence and Profits of—Utility of the Practice—How may be rendered leſs neceſſary—General Obſervations on.

THE practice of bringing land into a ſuitable condition for the growth of grain or other crops by means of fire, or the operation of paring and burning the ſurface or ſward, is probably a method of cultivation that was adopted at a very early period. It is a proceſs by which various changes are produced in the materials of the ſoils on which it is employed; ſome of which would ſeem to leſſen rather than improve their fertility, while others have obviouſly the power of promoting and augmenting it in a very conſiderable degree.

The action of the fire during the time of the combuſtion, eſpecially when carried to a great height, by forcing off and diſpelling much of the moiſture and elaſtic principles that they contain, as well as by reducing the proportions of vegetable and animal matters which may be mixed and incorporated with them, muſt have the effect of producing ſome degree of deterioration; while by its converſion of the freſh vegetable products, as the different kinds of coarſe plants and graſſes, into aſhes of an alkaline, ſaline nature—which, as has been already ſeen, poſſeſs the property of quickly rendering the portions of vegetable materials which may remain, proper for ſupplying the nutrition of plants—and by combining oxygen with the argillaceous, earthy, or other particles contained in them, in ſuch a manner as to be eaſily parted with during the incipient ſtages of vegetation, great advantage and improvement muſt unqueſtionably in many caſes be produced. It would ſeem to be chiefly on the former principle that the crops are generally found to be ſo abundant after land has undergone this proceſs; as the ſaline ſubſtance contained in the aſhes, though frequently ſmall in quantity, by bringing ſuch parts of the ſoils as were not before in a fit ſtate for the purpoſe of being applied to the ſupport of vegetables, ſuddenly into that ſituation in which they may be taken up by the abſorbent roots of the plants, a vaſt immediate fertility may be given, but which muſt ſoon have the effect of ex-

haufting the ground, if grafs or fome other kind of green crops be not cultivated in due rotation upon it. That fome effect of this fort takes place, in fuch cafes, is fhewn by the general experience of the moft correct practical agricultors.

There is alfo another way in which the faline matter thus formed may be conducive to the purpofes of vegetation, which is, by the great ftimulus which it is known to afford to the roots of growing plants, by which they may be induced to take up a larger proportion of nutrient matters from the foils on which they grow. And on lands prepared in this manner, efpecially where they are of the clayey kinds, it is probable that in fome inftances fo much oxygen may be combined, by means of the fire, with the particles of the clay, as, in particular fituations and circumftances, to render it capable of forming nitrous acid ;—as is the cafe with imperfectly-baked bricks *, which, where lime is made ufe of at the fame time with the afhes, may conftitute a fort of calcareous nitre ;—a fubftance which experiment has fhewn to be highly favourable to the procefs of vegetation.

In the method of cultivating lands, by means of paring and burning the furface, fuch loffes or deteriorations of foil as may be fuftained, muft evidently, as has been juft ftated, be produced by the quantity of vegetable or animal materials which may have been confumed or difperfed in the ftate of carbonic acid or other aërial forms ; as it is fufficiently known, that not a particle of the real earthy matter of the land can be deftroyed or carried away by the procefs ; it being left in moft cafes, where the bufinefs has been properly performed, probably in a much more mellow and friable condition than it was before the commencement of the operation, and perhaps more fuited to the abforption of elaftic principles from the furrounding atmofphere. A late ingenious writer, however, ftates the difadvantage in refpect to vegetable matter to be nineteen parts out of twenty †; but as he has not informed us what is the degree of lofs of fuch matter by this procefs, where it is incorporated in the ftate of foil, or the nature of the experiment from which his conclufion was drawn, we are inclined to believe that in this mode of preparation it is not by any means fo great, whatever it may be where the vegetable matters are themfelves fimply fubmitted to the action of the fire ; efpecially as in the trials which we have made by burning fuch foils as contained a large proportion of vegetable materials, fo as nearly to refemble that of garden mold ; confequently having confiderably more than is

* See Darwin's Phytologia, p. 225.

† See Dundonald on the Connection of Agriculture with Chemiftry, p. 147.

ufually met with in the lands that are fubjected to the operations of paring and burning, it has not been nearly in fuch a proportion even under a high degree of heat, which ought in every cafe to be as much as poffible avoided. And it is further conceived, by the fame author, that as it is only from the afhes of frefh or growing vegetables that faline matters, fuch as fixed alkaline falts, can be procured, none being produced from the burning of dead or decayed vegetable fubftances, the proportion of alkaline or other faline matters obtained by the procefs is fo fmall, that if the utility or advantage of the practice depended materially upon them, it would be more economical to purchafe them*. Experience has, however, fhewn, that whatever may be the proportion of faline matter which is formed in this way, a great deal depends upon the afhes which are produced ; as it has been found by thofe who have been largely engaged in the practice of this hufbandry, that on thofe parts where the afhes were fpread out upon the land as foon as the procefs was finifhed, the crops were highly luxuriant and productive ; while on thofe, where they had been from neceffity taken away, they were very mean and inferior, not being worth more than from an eighth to a tenth of the value of the others†.

The faline fubftances that are formed during the procefs of paring and burning, have been found to be the fixed vegetable alkali and vitriolated tartar : in the latter cafe the alkali of the confumed vegetable matters uniting with the fulphuric or vitriolic acid, which is frequently found to exift in fome ftate of combination or other in foils ‡. Thefe fubftances have been found by experiment to be capable of promoting the growth of vegetables in a confiderable degree §.

But in addition to thefe modes, in which the practice of paring and burning may be beneficially employed in the cultivation of land, there are fome others which feem of a more mechanical nature ; fuch as its reducing the various kinds of coarfe vegetable productions, as heath, furze, different forts of dwarf fhrubby plants, tough benty graffes, rufhes, and many other aquatics, into fuch a powdery carbonaceous ftate ||, as that, by the ready action of other fubftances upon them when thus reduced in the foils, they may become ufeful in promoting the growth of proper kinds of vegetables ; but which, without undergoing this procefs, could not by any means, from their great elafticity and

* See Dundonald on the Connection of Agriculture with Chemiftry, p. 148.

† See Young's Agricultural Report of Lincolnfhire, p. 257.

‡ See Dundonald, p. 149, § See Home's Experiments.

|| See Kerwan on Manures, p. 90.

almoſt indeſtructible properties, be prevented, for a very conſiderable length of time at leaſt, from rendering the ground too light and porous for growing any ſort of grain crops.

The ſtate or condition of the ſoils, in ſo far as reſpects their textures, as has been already ſuggeſted, muſt likewiſe in many caſes be greatly improved, being by ſuch means, when properly performed, rendered much more mellow and powdery, and thereby more proper for the admiſſion of the fibrous roots of the growing plants, as well as more capable of minutely dividing the particles of the manures, of whatever kind they may be, that are afterwards applied to them, and conſequently of affording a more full and equable ſupply of nouriſhment to the crops that may be cultivated.

And further, from the proceſs radically deſtroying, in moſt inſtances, when well performed, all ſorts of plants of the weed kind that may have eſtabliſhed themſelves in the ſoils which are ſubjected to the operation, the lands are left perfectly clean, and therefore in the moſt proper ſituation for affording the whole of the nutritious properties which they contain to the ſupport of the crops that may be put upon them.

From this view of the manner in which the proceſs of paring and burning may contribute to the improvement of land, the nature of the products that are formed by it, and the effects which they produce on the ſoils, it would however appear to be a mode of cultivation more adapted to ſome ſorts of land than others; as where they are light or thin, and there is much vegetable matter accumulated within the ſoil, whether from the decay of ſucceſſive crops of different ſorts of plants, for a great length of time, or the repeated applications of manures, without their having much ſward or coarſe vegetable products, ſuch as have been mentioned, growing upon the ſurface, it may do harm, eſpecially when a great degree of heat is not carefully guarded againſt, and judicious modes of cropping introduced, by leſſening the quantity of uſeful vegetable matter which they contain, without ſupplying any thing as a compenſation. But where they are more ſtiff and heavy, and there is a thick matted ſward (diſpoſed to the production of moſs, or covered with any ſort of rough, ſour plants, whether of the graſs or other kinds), it muſt, when cautiouſly practiſed, be a highly beneficial, and perhaps, in many caſes, an indiſpenſable mode of cultivation; not only by rendering them more open and porous in their textures, and reducing the coarſe vegetable maſs into that ſort of form in which it can be readily turned down and incorporated with the earthy materials, but alſo by

ſupplying a portion of ſaline matter that may operate ſtill further in promoting their fertility.

That theſe are the effects of the proceſs, and the caſes in which it ſhould be rejected or employed, ſeems evident, from the experience of the moſt exact and careful practical agricultors. It has been obſerved by an intelligent inquirer, who ſeems to have paid great attention to the effects of the different modes of practice that are employed in different diſtricts in the cultivation of land, that ſuch ſoils as are light and friable are every-where conſidered as unfit or improper for being treated by means of this proceſs *. And a very experienced writer, who appears to have cautiouſly examined the nature and effects of the operation, aſſures us, that he has many doubts about the propriety of extending the practice to ſuch ſoils as have been already fertilized and brought into a proper ſtate of tilth by the application of manures. "All kinds of earth," ſays he, "though they be in their original ſtate when dug from a great depth, infertile, become more fertile by degrees on being expoſed to the air on the ſurface, when impregnated by manures, and the gradual rotting of the roots of plants that grow upon them, along with the intermixture of the remains of animals that die there. They are thus in time converted into that kind of ſubſtance which we call *vegetable mold.* This vegetable mold, then," ſays he, "is neither a ſimple earth, nor a mixture of any number of ſimple earths together, but it is ſuch a mixture impregnated with the remains of animal and vegetable matters united with them. Theſe remains of organized bodies," he thinks, "communicate ſomething to the ſoil of an apparent oily or mucilaginous nature. Along with the fertility which it is thus ſeen to acquire, theſe give it a more friable texture and a greater facility than it originally poſſeſſed of abſorbing water in a proper manner, and retaining it to a certain degree. Now," ſays he, "there ſeems to be little reaſon to doubt that fire tends to alter, deſtroy, or diſſipate this mucilaginous quality which the mold derives from the ſpontaneous corruption of organized bodies. So that wherever the ſoil has been gradually fertilized by this proceſs, there ſeems reaſon to fear that the burning of its ſward will rather prove hurtful than beneficial †." It is, indeed, afterwards ſuggeſted, that theſe are given as reaſons for doubting of the propriety of the method under ſuch circumſtances, but not by any means as rules for practice. The reaſoning appears, however, to be founded in truth, and to be ſupported by

* See Donaldſon's Preſent State of Huſbandry in Great Britain, vol. III. p. 388.

† Anderſon's Eſſays, vol. III. p. 255.

the few facts and experiments that have been recorded in fuch a way as to be in any degree depended upon.

There is alfo another fort of foil on which the procefs of paring and burning muft be practifed with equal caution, or perhaps in fome cafes be wholly rejected, from the danger there is of its reducing the materials of which it is conftituted in too great a degree. This is that of the *peat* or *moffy* kind. "In this cafe," fays the able author mentioned above, "it is not the plants which grow upon it, but the very fubftance itfelf that ferved as a foil on which the plants grew, that is totally deftroyed by incineration. This fubftance is," continues he, "by burn-beaking, amazingly diminifhed in quantity; and the little that remains, inftead of foil, after this deftructive procefs, is an inert earth, which is more unfit for the purpofes of vegetation than any other that has ever fallen under my obfervation*." He therefore conceives the burning of fuch a foil as pernicious in every cafe, but more efpecially fo where there is no poffibility of ftopping the combuftion, after a thin paring of the furface or fward has been confumed, and to ftop its progrefs juft at that moment he knows to be a matter almoft impracticable. This is not, he affures us, the refult of mere opinion; it has been confirmed by innumerable proofs of the practical kind. And it has been obferved by others, that this has been the cafe in other forts of land; and that a material objection to paring and burning is, that in very dry feafons, when the moifture of the earth is very low, the fire catches the foil below and caufes what is called *pitting*; making great unfightly holes to the bottom of the moor, which with great difficulty are extinguifhed. About thirteen years ago a large common at Chatteris, in the Ifle of Ely, it is faid, was thus burnt up fixteen or eighteen inches deep, to the very gravel †. Thefe are, however, we fufpect, in many inftances at leaft, the effects of mifconduct or improper management, and of courfe afford little real objection to the practice when well executed.

We believe, indeed, notwithftanding the above opinion, fupported as it is by the great experience of the ingenious author, that in fome cafes moffy foils may be fubjected to the procefs of paring and burning with much benefit to the cultivator, provided that it be performed with proper care and attention. And it is unqueftionably practifed in various diftricts without any injury being produced by the deftruction of the materials that conftitute fuch foils ‡. On fuch kinds

* See Anderfon's Effays, vol. III. p. 257.

† See Agricultural Report of Lincolnfhire.

‡ See Agricultural Report of Lancafhire, p. 109. And of the Weft Riding of Yorkfhire, p. 149.

of ſoil more care will, however, probably be requiſite to prevent the fires from becoming too violent, than in ſuch as are compoſed of more earthy or leſs combuſtible ſubſtances.

But where the ſoils are of the latter deſcription, or ſuch as are of the ſour, heavy, ſtiff, and fenny kinds, and where they are overgrown with ſuch coarſe vegetable productions as have been already mentioned, there cannot be the leaſt doubt entertained of the propriety of adopting ſuch a method of practice in breaking them up and bringing them into a ſtate of cultivation. Indeed, however much the writers on agriculture may have differed in opinion on the propriety of paring and burning in other caſes, in theſe they ſeem to be nearly agreed, and in general conſider it as the moſt advantageous and ready method that can be employed.

On incloſing the waſte lands in the pariſh of Bows, in Yorkſhire, large portions, it is ſaid, were ſubjected to the proceſs of paring and burning; but the few perſons who ploughed up the ground without previouſly employing this method, had great reaſon to regret it *.

It is alſo remarked by an able writer, in ſpeaking of bringing into cultivation the chaſe lands in the county of Middleſex, that the impropriety of breaking up this kind of land without paring and burning, is manifeſted in the neighbourhood of Beech-hill, where land, after twenty years' incloſure and cultivation, is in a worſe ſtate now than it was originally. Well would it be for the owners of ſuch allotments, ſays he, if they could now pare and burn it; but it has been ploughed, and not producing more than what the vermin deſtroyed, laid down in ſo rough a ſtate to graſs, as to be incapable of being pared and burnt: the original wiry bent and dwarf ſhrubs are now growing in full vigour: and that on the incloſure of Stanwell, in the ſame county, the allotments on Hounſlow-heath ſucceeded well under the perfect practice of paring and burning; and ill, where the turf was ploughed without the application of fire. In the former caſe the land was immediately fit for turnips, tares, barley, and clover: in the latter, the tough, wiry bent, heath, and dwarf furze, kept the land too light and ſpongy for any crop. Even rolling, he aſſerts, cannot keep it down, for its elaſticity raiſes the ſoil ſoon after the roller has paſſed over it, and it is of ſo imperiſhable a nature, that it is likely to plague the farmer for many years. The difference between the two methods of breaking up rough ground, is, he thinks, more than the value of the freehold in favour of paring and burning,

* See Annals of Agriculture, vol. XII. p. 253.

which immediately opens a fource of great profit; whereas the other proceeding leads to nothing but expence and difappointment.

And in addition to this it is obferved, that paring and burning has more merit than any other manure, in its property of converting heath, furze, fhrubs, and wiry bent, into coal, moft fitly prepared for the food of plants; and that it will pulverize fuch a foil as much in two years as all other means can effect in twenty *.

And others contend, that on any fort of foil which has not before been reclaimed from a ftate of wafte, and where furze, broom, brambles, ferns, rufhes, &c. abound, thefe operations, when properly performed, are productive of the moft beneficial confequences. That there is perhaps no other method that could be devifed, fo well adapted for preparing land in a ftate of nature, and incumbered with fuch productions, for valuable crops with expedition and certainty; and that on this account, paring and burning might well be confidered by Virgil, and other ancient writers, as a fure means of improvement. And further, that in fuch cafes they are fo at this period, may, it is thought, be proved by the concurring teftimony of thofe to whofe lot it falls to cultivate the common or wafte lands in many of the new inclofed diftricts of the kingdom. It is further ftated, that inftances are frequently met with of great advantage refulting from this mode of management; and that wherever land is rendered unfit for cultivation by the incumbrances that have been mentioned, the Devonfhire mattock and the paring-fpade may be ufed with the greateft propriety†.

It has been likewife remarked by Mr. Young, in the Agricultural Survey of Suffolk, that "in that diftrict they could not cultivate without this capital affiftant. It is fcarcely poffible, profitably, to bring boggy, moory, and peat foils, from a ftate of nature into cultivation, without the affiftance of fire, which is the moft effective deftruction of the fpontaneous growth, and never fails, but becaufe the men employed do not pare deep enough."

From fuch cafes as have been ftated above, where much deftruction has been produced by the improper management of the burning in a particular fort of land, the notion of the foil itfelf being leffened, which has formed a great objection to the practice, feems to have originated; but it has been already fhewn, that no lofs can poffibly take place, but from the confumption of a fmall por-

* Middleton's Agricultural Survey of Middlefex, p. 290.

† See Donaldfon's Modern Agriculture, vol. III. p. 389.

tion of the vegetable material that may be contained in it, either in a living or decayed ſtate, or the diſſipation of moiſture and elaſtic matters; and that there is reaſon to ſuppoſe the loſs in theſe reſpects is not ſo great as has been commonly imagined.

It has been remarked that clay ſoils are much more apt to be injured by paring and burning than any others. Where the flame in the heaps is allowed to burſt out with great violence, the ſoil is apt to be reduced to a bricky ſort of ſubſtance, incapable either of imbibing any quantity of moiſture, or of again becoming uſeful in promoting the growth of plants; hence, in ſo far as miſmanagement takes place in this reſpect, in ſo far is the depth of ſoil permanently leſſened. But were paring and burning to leſſen the ſoil to the degree which ſome people aſſert, there would not have been an inch of ſoil in the counties in the ſouth-weſt part of the iſland many years ago. Such an objection to the practice of paring and burning, does not therefore appear to carry much weight along with it. It is no doubt very ſpecious and plauſible in theory, but the practice of ages has proved it in a great degree ill founded *. But by others it is contended, that the large portion of powdery brick earth produced in this way has a tendency, by being incorporated with the ſtiff retentive mold, to render it more mellow and pulverizable †; an effect which we have already ſuggeſted as uſeful in promoting the growth of crops.

Mr. Young, in ſpeaking of the different objections which have been made to this practice in fen diſtricts, from the ſuppoſition that it tends to reduce the ſoil greatly, as is evinced by the ſinking of drained lands that have been pared, ſays, that it has been found that a ſeries of ploughing and cropping ſtiffens, concentrates, and diminiſhes the lighter kinds of fen ſoils; and that the ſtratum of black peat earth, which on their firſt breaking up was conſiderably deeper than the plough ran, has been within the memory of the preſent occupiers, without any freſh paring and burning, ſo far reduced, that without taking more mold, or ploughing deeper than they formerly had been accuſtomed to do, they have not only paſſed the whole of the black peat ſtratum, but have ploughed up two or three inches of the clay beneath it; and that if it be granted, which he thinks will ſcarcely be denied, that the ſurface of the adjacent depaſtured fen lands, from the decay of vegetables, dung of animals, and the ſoil brought thither by the waters from the neighbouring high lands, has been continually, though ſlowly, increaſing, there will then appear other reaſons for their preſent

* See Modern Agriculture, vol. III. † See Anderſon's Eſſays, vol. III. p. 252.

different level than mere paring and burning. "It is well known," fays he, "that earth is not to be diffipated by combuftion; it is more likely that this appearance proceeds in the firft place from the light peaty earth of a fen foil being gradually confolidated by alternate cultivation and pafturage, fo as to fink below the level it formerly preferved in its uncultivated ftate; and in the next place, may it not proceed from the commons gradually rifing higher by the accumulation of mud and foil depofited by the upland waters?"

Thefe facts, which feem to reft upon the foundation of practical experience, fufficiently fhew that little danger is to be apprehended from the deftruction of the foil when the procefs is properly performed, and a correct method of after-management purfued.

In the method of performing the procefs of paring and burning, there are fome flight differences in the practice of different diftricts; and perhaps in managing this bufinefs, an attention to the nature of the lands may be as neceffary as in other cafes of hufbandry, as it would feem that fome, as thofe of the more clayey and heavy kinds, would be moft benefited by having the fire to come as much as poffible into contact with the whole of the fuperficial parts of them, without being carried too far, as by that means they may be rendered more proper for the reception of the roots of vegetables after being flightly ploughed, as well as more fuitable for fupplying nourifhment to them; while in others, as thofe of the more light and thin defcriptions, it might be moft advantageous to merely confume the thin paring of fward after being piled up for the purpofe, without permitting the fire to exert its influence upon the mold or foil immediately below, as in this way there would not probably be fo much danger of injuring the ftaple, by deftroying the vegetable matters contained in fuch foils.

In the firft of thefe modes of burning the fward, it is obvious, that the fods or parings fhould be piled up as little as poffible into heaps, the advantage of a fuitable feafon being taken to apply the fire to them in the ftate in which they lie, or are fet at firft after being cut up, or after a few only have been placed together, as happens in fome inftances where they are immediately after being cut, fet on edge to dry, and placed in ferpentine directions, in order to prevent them from falling over; but in the latter cafes they fhould be formed or built up into little circular heaps or piles, fomewhat in the form and fize of the little cocks made in hay-fields, the fods being placed the grafs-fide downwards, in order to admit air; but the openings both at the bottoms and tops, after they have been fully fet on fire by fome combuftible fubftance, fuch as ftraw, &c. are

to be clofed up, as well as thofe in other parts covered by an addition of fods; fo as that the combuftion may proceed in a flow, fmothering manner, fuch as is practifed in the making of charcoal. When the whole of the earth in each of the piles has been acted upon by the fire, the heaps may be fuffered to extinguifh themfelves by flowly burning out.

There is another method of practice of this kind, which is much in ufe in fome diftricts, as in Devonfhire and Cornwall, for breaking up and preparing grafs lands for the reception of what have been termed fallow crops, which is that of *fkirting*; in performing which a part of the fward or furface is alternately left unturned, upon which the next thin furrow flice is conftantly turned, fo that the fwards of each come in contact, by which means the putrefactive fermentation is fpeedily excited, and the greateft part of the graffy vegetable matter converted into manure; what ultimately remains undeftroyed being, after repeated crofs-cuttings with the plough and harrowings, all the mold or earthy matter having been previoufly well removed from the roots of the plants by fhaking, collected into fmall heaps (which is done either by the hand or with iron-headed rakes, conftructed for the purpofe), and burnt, the afhes being then fpread evenly over the land *. The operation when managed in this way is termed *beat-burning*, and would appear to be the moft proper and ufeful on land where the turf or fward is not very tough or matted together, and where there is little or no coarfe vegetable products growing upon it.

In accomplifhing the operation of paring, or of feparating the fward from the furface of the foil, feveral different inftruments are made ufe of in different parts of the kingdom: that which was the moft employed in the infancy of the art was a kind of curved mattock or adz, about feven or eight inches in length, and five or fix in breadth; and which from its fhape would appear to have been better adapted for cutting up the roots of brufh-wood, furze, broom, or other coarfe fhrubs, than for paring off the furface of a field free from fuch incumbrances. This inftrument is, however, it is faid, common in the fouth-weftern diftricts; and that, though it no doubt retains in a great meafure the fhape of the inftruments firft ufed for the purpofe in that part of the country, when the lands were in a very different ftate, yet the labourers who are in the practice of ufing it, are able to pare off the fod with great dexterity and difpatch †. But in other diftricts, where the fod is pared off by manual labour,

* See Agricultural Report of Devonfhire.

† See Modern Agriculture, vol. III.

the ordinary *breaſt-ſpade*—in ſome places called the *breaſt-plough*, and in Scotland the *faughter-ſpade*—is moſtly employed. The iron or cutting part of this implement is about eight or nine inches in length, and from ten to twelve in breadth, having frequently a kind of edge riſing up a few inches at the right-hand ſide of the turf next to the unmoved ſward. This inſtrument, which is formed with a fine edge, is forced forward by the ſtrength of the arms of the perſon uſing it, and by preſſing the breaſt againſt that part of the frame or ſhaft which is held in the hand. In working the tool, the labourer generally cuts the ſods at about an inch or an inch and a half thick, and from ten to twelve broad; and when the ſpade has run under the ſod to the length of about three feet, he throws it off, by turning the inſtrument to one ſide, and proceeds in the ſame way, cutting and throwing over the ſods, the whole length of the ridge. In this way of performing the operation the labourers, by following each other with a ſlice of the ſward or ſurface of the land, accompliſh the buſineſs with much eaſe and expedition.

Another inſtrument that is ſometimes uſed for paring the ſod is the *horſe-paring-plough*, an implement made of different conſtructions, according to the circumſtances of the ground to be pared. In the fenny diſtricts on the eaſtern coaſts, where paring and burning is practiſed on a large ſcale, they have ploughs conſtructed for the purpoſe of a particular form, but which vary from the common ploughs chiefly in the breadth and ſharpneſs of the ſhare or ſock. They are admirably calculated for paring off the ſward or ſod of ſuch grounds as are level, and where neither ſtones, bruſh-wood, ant-hills, nor other impediments obſtruct their progreſs; but where ſuch obſtructions preſent themſelves, the breaſt-ſpade or common team-plough, with a ſmall alteration of the ſhare, will be found preferable, both in reſpect to the extent of ground that can be pared, and the ſuperior manner in which the work in ſuch caſes can be performed *. Ploughs, from their great expedition and regularity of performing the buſineſs, ſhould always probably be made uſe of where the nature and ſituation of the land will admit them, in preference to ſuch tools as require manual labour. In ſome of the weſtern counties the common plough only is uſed. There the old graſs-fields, when it is propoſed to burn the ſward, are *rib* or *ſlob furrowed* about the beginning of winter; and being again croſs-ploughed the following ſpring, the ſods are collected and managed in the manner mentioned in ſpeaking of ſkirting. In theſe caſes the plough has, however, a

* See Modern Agriculture, vol. III.

wing turned up on the furrow fide of the plough-fhare, by which the furrow is cut any breadth required. The work is alfo fometimes done by means of the fpade, mattock, and breaft-plough, in fuch cafes.

In refpect to the feafon for performing this operation, it may be obferved, that the months in which the greateft quantity of land is pared and burned are April, May, and June: the particular period muft, however, always depend much on the ftate of the weather, the nature of the crop, and the farmer's convenience. But for accomplifhing the work with the greateft difpatch, and alfo with the leaft trouble and expence, a dry feafon is obvioufly the beft. The prudent farmer fhould not embark in the undertaking, unlefs there be a reafonable probability of his accomplifhing it while the weather keeps dry and favourable. The latter end of May or the beginning of June, when the hurry of the fpring feed-time is over, in the more northern diftricts, when a number of hands can be moft eafily procured, may upon the whole be confidered as the beft and moft convenient feafon; as at this period the green vegetable products are in their moft fucculent and full ftates, and of courfe may probably afford more faline matter; but in the more fouthern counties either a much earlier feafon muft be taken, or the interval between the hay feafon and the harveft-time muft be fixed upon, the latter of which is, on the principle juft ftated, evidently the beft, where the extent of ground to be burnt is not too large. In other feafons it would frequently be impoffible to procure a fufficient number of hands for performing the bufinefs. In bringing wafte lands into cultivation, where an extenfive tract of ground is to undergo this procefs, the autumn may in many cafes afford a convenient opportunity for the operation.

As the crops that are fown after paring and burning are various, and as the feafon for performing the procefs muft in many cafes depend in fome meafure on their nature, we may obferve that when rape or turnips, which are the moft prevailing crops in fuch circumftances, are to be cultivated, the end of May or the beginning of June will be the moft proper time: but if barley or oats be to be fown, the paring and burning muft be completed as early in fpring as the nature of the feafon will admit; and when lands are pared and burned as a preparation for a crop of wheat, July, or even the beginning of Auguft, may in favourable feafons anfwer; but it is better to have the ground ready fooner.

The depth to which lands of different qualities may be pared with the moft advantage, is alfo a point that would feem to require fome attention in the conducting of proceffes of this nature; as it can hardly be proper to pare light, thin, ftapled foils, to the fame depths as thofe of the more deep and heavy

kinds. This ſhould probably, in ſome degree, be regulated by their particular nature, and their differences in reſpect to ſtaple and heavineſs. Mr. Boys, however, who is in the habit of breaking up thin chalky ſoils, and ſuch as have been in tillage in this way, obſerves, that in Kent, where the method of paring moſt in uſe is with down-ſhares or breaſt-ploughs, they take off turfs as thick as the nature of the ſoils will admit, from half an inch to two inches; the *thicker* the *better*, provided there be a ſufficient portion of vegetable matter contained within them to make them burn well *. The moſt uſual depths of paring are, however, from one to three or more inches.

When the ſeaſon is not very wet, the turfs will commonly be ſufficiently dried in about a fortnight or three weeks, even without being turned; but in rainy weather they require a longer time, and muſt be turned more than once to prevent their ſtriking out roots and ſhoots, which might hinder them from burning.

When the turfs have fully undergone the proceſs of burning, and are reduced to the ſtate of aſhes and a powdery earthy matter, the whole ſhould, as ſoon as poſſible, be ſpread out over the land in as regular and equal a manner as the nature of the work will admit of; for without great attention in this reſpect, great inequality in the crops may take place; beſides the ſoil will be made lighter in ſome places than in others, which may be diſadvantageous in the ſame way. The ſpreading, where it can by any means be accompliſhed, ſhould always be performed before any rain falls; as where this point is not attended to, a great loſs may be ſuſtained by the ſaline matters being carried down in a ſtate of ſolution, and their beneficial effects in a great meaſure loſt before the crops are in a condition to receive them. In order to ſecure the full influence of the aſhes, the land is frequently ſlightly ploughed over immediately after the aſhes are ſpread out. And it is ſtated by Mr. Donaldſon, that " thoſe who are more than ordinarily attentive in this reſpect, only rib or ſlob furrow the field, ſo that the aſhes may be got covered up with the greater expedition and diſpatch." By this mode they cannot probably, however, be ſo equally mixed with the ſoil as by that of ploughing the whole field with a very ſlight furrow, ſo as juſt to cover them.

The expence of preparing lands by the operations of paring and burning, muſt obviouſly vary according to the nature and ſituation of the land, the method in which they are performed, and the cuſtoms of the diſtrict in regard to the price of labour. On the thin ſort of chalky ſoils it is obſerved by an expe-

* See Agricultural Report of the County of Kent.

rienced agricultor, who is accuftomed to have fuch lands prepared by this means, that the expence for paring at a moderate thicknefs, where the land is not very flinty, is twenty fhillings per acre; for laying it up in heaps and burning, ten fhillings; and for fpreading the afhes, three fhillings; and that a coat of manure is thus produced on the land of from eighty to one hundred and fixty cart-loads per acre, for the trifling expence of thirty-three fhillings. A hundred cart loads of dung purchafed from neighbouring towns and villages, at the diftance of three miles from the land, would, he fays, coft, carriage home included, ten times the price of down-fharing, and yet would not improve the land more. But that, where the land is well covered with turf, it may be ploughed for burning about two inches deep, with a common plough, drawn by a pair of horfes early in the fpring, and as foon as a drying wind fets in, the turf be laid in heaps and burnt by labourers for one pound one fhilling per acre, which will produce near two hundred cart-loads *. As the author has not informed us of the quantity contained in fuch loads, it is impoffible to decide with any certainty in regard to the benefits of the procefs in fo far as manure is concerned; but his ftatements fully fhew that it is more confiderable than is generally fuppofed.

And in fome fen diftricts, where the original furface is rough and unequal, from great tufts of rufhes, &c. called *haffocks*, Mr. Young obferves, that fome perfons cut them with fpades at the expence of five to ten fhillings an acre, and others with the plough. Paths for the horfes are in that cafe to be cut by hand, and the plough made on purpofe, and called a *haffock-plough*, cuts laterally much beyond the line of its draught. But opinions are faid to be in general, that the hand-work is the cheaper; in either cafe, the haffocks are dried, heaped, burnt, and the afhes fpread. After this they go over it again with a very complete and effective tool, called a *fen-paring plough*, the furrow of which is burnt †.

In the management of land by means of paring and burning, it will conftantly be neceffary to attend to fuch a mode of cropping as will tend to its improvement, whatever may have been the manner or kind of foil in which the procefs was performed. Without a nice and exact attention in this refpect, much injury may frequently be done, and an ufeful practice be brought into difrepute. When the nature and fituation of the land will admit of them, as in the lighter forts of foils, the growing of turnip or rape crops to be confumed on

* See Agricultural Report of the County of Kent.

† See Agricultural Survey of the County of Suffolk.

the ground would feem to be moft proper for the firft year; then a white or grain crop, as oats, or wheat; after that, turnips again, or in fome cafes, peas, beans, or fome fort of green crop, to be eaten off if poffible by fheep; and laftly, a grain crop with grafs feeds: but on the heavier forts of land, where the turnip hufbandry cannot be fo well introduced, cole, clover, and bean crops, may often be interpofed between thofe of the grain kinds with the moft propriety and advantage. And it would feem that the interpofition of green crops ought on the whole to be more frequent in the former forts of foil than on thofe of the latter, on account of their containing, in general, a lefs proportion of vegetable matter. It is often attended with great advantage to apply fome fort of manure, fuch as lime, with the fecond crop of turnips in cafes of thefe kinds.

It is afferted, that in fome of the weftern diftricts, where the method of paring and burning is very much practifed, and held in high eftimation, old fainfoin lays, and all fuch fwards as are of a fufficient texture, are ufually broken up in this way. Turnips are frequently the firft crop; and from the frefhnefs of the land, and the good effects of the afhes, a large crop is moftly produced. But as in thofe cafes the time is too fhort to get the land in proper tilth for the fucceeding crops of barley, grafs feeds, and other fimilar crops, it is often adopted as a better method to fow wheat in the firft inftance on one ploughing; after which, from the afhes being ftill frefh in the ground, a crop of turnips may be as certainly depended on, and there is a fufficient length of time to get the land into a complete ftate of tilth. Wheat ftubbles, of the more graffy kinds, which will produce a tolerable quantity of afhes, are alfo frequently pared and burnt for turnips with a confiderable degree of fuccefs. In fhort, when this practice is properly followed up with the turnip and clover hufbandry, its good effects cannot it is conceived be difputed *.

In others, cole feed is fown on a fhallow ploughing, and never harrowed, in order not to difturb the whole furrow; but rolled, or lightly bufh-harrowed. This is intended either for a crop of feed, or for fheep-food: in the latter cafe, it fells in fome places for a guinea an acre; in the former, for two or three guineas. Oats are then fown; the crop is productive, and the land, if well laid down to grafs, becomes good meadow. But the management in this refpect is frequently very bad, only clover and ray grafs being fown, and after fix or feven years pared and burnt again; inftead of which, if proper feeds were fown, the land would be ever after in a ftate of improvement.

* See Agricultural Survey of Gloucefterfhire.

Where there are poor, wet, cold, hungry paftures and neglected meadows, over-run and filled with all forts of rubbifh, and abounding with too few good plants to render their improvement eafy without breaking up, it is obferved, that thefe fhould be pared and burnt; not to keep under the plough, to be exhaufted and ruined, which is infallible, and the land left in a worfe ftate beyond all comparifon than it was before, but to be laid immediately to grafs, that is, as foon as the courfe of hufbandry neceffary will admit. This, it is conceived, ought to be without variation, under any pretence whatever, in this courfe of crops: 1ft Pare and burn for turnips to be fed on the land with fheep: but in moift-bottomed lands, rape will often fucceed better than turnips; and the fheep feed better with rape upon fuch lands. 2d. Oats; and with thefe oats the grafs feeds fhould be fown. The oats and the turnips, it is afferted, would more than pay all the expence of a previous hollow draining, fhould that be neceffary; of the paring and burning, and every other charge; and the change, from a very bad pafture to a very fine one, would all be neat profit. The tenant, it is contended, would be greatly benefited, and the landlord find his eftate improved, if let as farms ought to be let, with an abfolute exclufion of felling a lock of hay under any pretence whatever *.

And it is further afferted, that this method is practifed with great fuccefs in the *fen land* in Lincolnfhire, the bufinefs being performed by means of the plough, and cole feed afterwards fown. In fome cafes, horfes and ploughs are found, and the labour put out; which, including a ploughing in order to turn in the afhes, is done at feven fhillings an acre: the cole is fed with fheep, and is worth three pounds an acre; but felling price, forty to fifty fhillings. Then oats, eight quarters an acre, and ten quarters has been had; then cole and oats again; being laid down with fourteen pounds of white clover, and one peck of ray, the grafs lets at twenty fhillings. It is found to be a great and lafting improvement of the land. This is conceived to be a low eftimate, from the land keeping five fheep an acre, from Lady-day to Michaelmas, and one and a half on the acre in the winter. Where then, it is enquired, is the fuppofed mischief of this practice† ?

There are other forts of lands, as dry, rough fheep-walks, covered with ling, furze, broom, &c. which fhould alfo be broken up in the fame manner, but univerfally to be laid down again with the graffes fuitable to the foil and to fheep. On weak, thin, ftapled land, two crops of corn, after paring and burning, may often be pernicious. Perhaps they might be well laid down without a fingle

* See Agricultural Report of Suffolk.

† See Young's Agricultural Survey of Lincolnfhire.

one, which would be a better method of management. It is alfo fuppofed by fome able agricultors, that it would be better to take, in fuch cafes, two or three fucceffive crops of turnips, in order to completely eradicate all the feeds of the ling, furze, and broom, before the land is laid down to grafs, as otherwife thefe plants may appear with redoubled vigour. Thefe obfervations feem juft, and to be founded in good fenfe, reafon, and experiment; they place the abfurdity of indifcriminately condemning this mode of agricultural improvement in the cleareft point of view; as the injury that may take place in fome cafes may be occafioned by an injudicious and improper method of cultivation.

It is further remarked by an experienced practical agricultor, that, of all the improvements in the cultivation of land that have hitherto been made ufe of in the diftrict where he refides, this ftands foremoft; fome of the very worft land having been made to produce excellent crops; and poor chalky downs, of fcarcely any value in their original ftate, are by it made to produce good turnips and clover, and crops of corn, often equal in value to double the fee fimple of the land. Inftead of the land being injured by the operation, as fome theoretical writers have imagined, provided it be under a proper fyftem of management and fairly dealt by, it is, he thinks, put into a progreffive ftate of improvement from the time of its furface being burnt. It has frequently, fays he, happened, that land after burning has been fown with corn four or five years in fucceffion without being folded with fheep, or any part of its produce ever returned in manure; even *charlock* and other weeds have been fuffered to remain, by which it has been annually burthened with a double crop; hence it has been left in an impoverifhed ftate, and the burning is unjuftly condemned for the mifchief done by the negligence and rapacity of the cultivator. Let the land when burnt, continues he, be perfectly cleaned from charlock and other weeds, by growing turnips until the weeds are totally eradicated by hoeing, &c. Let the turnips be fed off the land, by fheep lying on the land day and night; then fow it with barley and clover; the latter to be fed off with fheep, folding them on the land for wheat. Laftly, return the ftraw produced upon the land in manure, mixed with clay or loam, or any other frefh earth that is near at hand, for a fecond Norfolk rotation, which may be repeated; or the land may be fown with fainfoin, to remain till a turf is formed fit for paring and burning again. This plan being purfued, the practice of burning the foil will, he conceives, not give any caufe of complaint either to landlord or tenant. Theorifts, fays he, exclaim, that by paring and burning the ftaple of the land is reduced, and the

ſoil is waſted ; which may be ſomewhat true : but all this is very immaterial, if fine crops of corn can be produced where none ever grew before, and the land at the ſame time be improved *.

In ſpeaking of the injudicious and improper modes of cropping repeatedly with white or grain crops after this proceſs, an intelligent practical writer forcibly obſerves, that if a dung-hill were given to a bad farmer, and it was uſed on ſimilar principles, it would almoſt equally exhauſt the ſoil ; yet who has found out that dunging land is bad huſbandry ? Paring and burning gives, ſays he, a dung-hill alſo : it is bad management alone that converts it into an evil. Make it the preparation for graſs, and all is ſafe † ‡.

* Boys's Agricultural Survey of Kent.

† Young's Agricultural Survey of Suffolk.

‡ The practice of paring and burning has been found ſo advantageous in ſome caſes, as to render lands, the produce of which was not worth two ſhillings and ſix pence, in the courſe of four years capable of producing two valuable crops of corn, and as many of turnips, and to be rented at twenty ſhillings per acre.

The expences and returns of breaking up freſh land of the ſtiff loamy kind, and cropping with oats and peas, is ſtated in the following way by Dr. Wilkinſon, in the fifteenth volume of the Annals of Agriculture. The ſummer being loſt in preparing the land for a wheat crop, the crops are, he obſerves, charged with two years' rents and taxes.

OAT CROP.

	£.	s.	d.
Rents, for two years, per acre	1	0	0
Poor-rates	0	3	0
Road levy	0	1	0
Stocking the buſhes	0	6	0
Paring and burning	1	9	0
Levelling hillocks	0	4	6
Spreading aſhes	0	1	6
Once ploughing	0	10	0
Harrowing	0	2	0
Four buſhels of ſeed-oats, at 29*s.*	0	11	0
	£. 4	8	0
Sold ſeven quarters of oats, at £.1. 1*s.* per quar.	7	7	0
Seeds and expences	4	8	0
Profit per acre	£ 2	19	0
Straw, not charged, more than defrayed expences of mowing and threſhing			

Z z PEA

The kinds of grafs feeds that may be the moft fuitable after the operation of paring and burning, muft evidently be different according to the nature and quality of the land. In the lighter forts of foil, thofe kinds of graffes that cover the earth well will in general be the moft proper. On chalky foil faintfoin may moftly be employed to the greateft advantage. On the fenny forts of foil, marle-grafs, with a little meadow foxtail-grafs, will frequently be found the moft

PEA CROP.

	£.	s.	d.
The expences the fame as for the oat crop, with the addition of 5s. for four bufhels of feed, at 3*s*. - - - -	4	13	0
Sold four quarters of peas, at 32*s*. - -	6	8	0
	£. 1	15	0

From the ameliorating nature of pea crops, and the excellent ftate in which they leave the land for a crop of wheat, they will, it is fuppofed, be on the whole more advantageous than the oats.

The expences and profits on cold, moffy, old meadow lands in Yorkfhire, with a north-eaft afpect, cultivated in this way for turnips, as given in the twelfth volume of the fame work by Mr. Middleton, are thefe:

	£.	s.	d.
Paring - - - -	0	9	0
Drying and burning - - -	0	5	0
Spreading the afhes - - -	0	1	0
Ploughing once - - -	0	6	0
Harrowing - - -	0	2	0
Seed, ¾ lb. and fowing - - -	0	0	6
Weeding (in pared and burnt land little neceffary) - - -	0	0	6
	£. 1	4	0
Rent, tythe, taxes, and affeffments -	0	18	0
	£. 2	2	0
The turnips, a plentiful crop (large fizes, about a foot diftance), eftimated in feeding ftock by the acre, at - -	5	0	0
Profit per acre	£. 2	18	0

It is added, that "in that neighbourhood the ufual agiftment price is fix pence a week for fattening wethers, and three pence a week for hogs (lambs of the preceding feafon), to eat the broken turnips and fhells left by the wethers."

beneficial. And a ſmall mixture of the fineſt ray, or darnel-graſs, is likewiſe found to anſwer well. For marle-graſs, though it has ſome reſemblance to red clover, is materially different in its effects; the former being found unfriendly to all natural graſſes, while the latter is quite the reverſe. This is a fact that has been eſtabliſhed by extenſive experience. One other very material advantage reſulting from the cultivation of marle-graſs, is ſaid to be, that neat cattle are not ſo liable to ſwell by eating it in moiſt weather, as they are from red clover; nor is its hay ſo dangerous to the horſes' wind as that made from clover.

And it may be further obſerved, that the heavy or clayey ſoils will in moſt caſes require the largeſt proportions of graſs ſeeds to be ſown upon them, in laying them down after this preparation.

From the great eaſe and expedition with which all thoſe coarſe ſorts of land, which have been mentioned as proper for being broken up by this means, are rendered fit for the growth of crops of different kinds, ſuch as thoſe of grain, rape, turnips, potatoes, &c. as well as from the very abundant produce, which is generally the caſe after ſuch preparation, it cannot be doubted, but that where proper attention is paid to the conducting of the proceſs and the method of management afterwards, it muſt be highly beneficial, and probably the beſt that can be adopted. It has indeed been lately remarked, that " when the huſbandry that ſucceeds paring and burning is judicious, no mode of improvement can be compared with it; *for it is certain to produce great crops of turnips and grain, and theſe are certain means of future fertility in the hands of a judicious farmer* *."

In addition to this, it is likewiſe obſerved, that ſuch kinds of land, when they are returned again to the ſtate of graſs after having undergone the proceſſes of paring and burning, generally produce not only a much leſs coarſe, but more ſweet and plentiful herbage †.

But notwithſtanding the great advantages that evidently reſult from the operations of paring and burning on ſuch kinds of land as have been already deſcribed, it is probable that by adopting better ſorts of management in reſpect to the modes of cropping in thoſe that have been under tillage, as by alternating green crops of ſome ſort or other with thoſe of the grain kinds, and the full practice of the convertible huſbandry, or that of laying them down to graſs in a proper manner, and at ſufficiently early periods after they have been converted to the purpoſe of growing grain, the neceſſity of having recourſe to ſuch practices may in a great meaſure be obviated. Indeed it has been well

* See Agricultural Survey of the North Riding of Yorkſhire, p. 22.

† See Experienced Farmer, vol. II. p. 8.

remarked by an intelligent writer, that whenever clean-fallows and ſuitable fallow-crops ſhall have been introduced and properly interpoſed between thoſe of the grain kind, as is the practice of the moſt correct modern cultivators, *burning-beat* will certainly be no longer requiſite *.

In ſhort, the neceſſity of employing theſe methods in the breaking-up of ſuch graſs lands as have been already in the ſtate of tillage, would ſeem in ſome reſpect to ariſe from their being kept under the graſs ſyſtem too long; as by that means, in many ſituations, their produce becomes coarſe, and the ſward ſo tough and matted as to be incapable of being broken up, or reduced by the other modes of cultivation. This is ſhewn more fully by the obſervation, that in ſuch lands as are cultivated in the moſt advantageous manner in reſpect to their becoming productive, as by the alternate courſes of grain and graſs, the operations of paring and burning, if not wholly impoſſible, are at leaſt extremely difficult to be performed, as the ſward or turf of ſuch grounds, from their being clean, and laid down in a proper condition, is moſtly ſo tender as not to be capable of being kept together in order to undergo the proceſſes†.

From what has been advanced, it is obvious that in performing the proceſſes of paring and burning care ſhould be taken that the burning be not carried ſo far as to prove injurious by the conſumption of the vegetable materials in the lighter ſorts of land, or by rendering the earthy matters too hard in the clayey ſoils, by permitting the ſod to become too dry before the burning is begun. The more the latter proceſs can be conducted in a ſmothering manner the better, ſo that the fire acts upon the whole. The thickneſs of the turfs ſhould be regulated by the ſtate of the ſward and nature of the vegetables by which it is covered; the aſhes being immediately after the burning ſpread out equally over the whole of the ſurface, and very lightly ploughed or harrowed in; corn and green crops, according to the nature of the land, being then cultivated in proper rotation, and returns of manure, in proportion to the abundance of the crops that may be produced, made to the lands, the whole in due time being laid down to the ſtate of graſs. By theſe means the danger of exhauſting the lands will not only be avoided, but great improvement in many inſtances be effected.

* See Marſhall's Rural Economy of the Weſt of England, vol. I. p. 149.

† See Modern Agriculture, vol. III. p. 397.

PARING PLOUGH FOR ROUGH LAND.

PLATE L.

Paring Plough for Rough Land.

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In this plate are two ſide views of a paring plough, given by Mr. Young, for coarſe rough land. The ſhare is ſix inches in width, and riſes or ſinks by means of pivot 2, which ſcrews into the holes 3. It is a highly uſeful implement, being capable of performing its work in caſes where the fen-paring plough cannot ſtir at all. It was in uſe at Sheffield Place, the ſeat of the Right Hon. Lord Sheffield, P.B.A. thirty years ago, having been procured from Cheſhire, where it had been employed on the farm of Sir George Warren.

SECTION X.

Fallowing of Land.

Fallowing—In preparing Lands by Means of, various Changes take place in the Substances that form Soils—A high Degree of Mellowness and Pulverisation mostly effected by it—By such Means the different Materials become more uniformly and extensively blended together—Advantages of this in the Growth of Crops—Dews and Moisture more readily admitted thereby—Destruction of Weeds in, also useful in improving the Soils—Other Modes in which Pulverisation may be beneficial—By admitting the atmospheric Air more abundantly into the Interstices of the Soils—By the Formation of carbonic or other Acids in Consequence of it—Of nitrous Acid—Of fluid carbonic Acid—Of Ammonia, or volatile Alkali—The Practice of Fallowing, in these Ways, more extensively beneficial than has been supposed—Is more adapted to some Sorts of Land than others—In some unnecessary or injurious—On the lighter and more dry Soils—On such as are rich from the Applications of Manures—Manner in which it proves hurtful in each—Useful in the wet, stiff, and tenacious clayey Soils in various Ways—By the Pulverisation thus afforded the Roots of Plants are admitted more freely—By permitting atmospheric Air to enter more fully into the Cavities of the Soils the Matters that promote Vegetation are more extensively produced—The Roots of Plants allowed to penetrate and take them up more freely by the great Increase of Surface that thus takes place—The Destruction of Weeds more effectual in this Way—Can only perhaps be effected in wet Soils by Summer Fallowing—Ploughing them in Winter often renders them more stiff and adhesive—Dry gravelly Soils may mostly be managed without this Process; but wet, clayey ones cannot—No Modes of Cropping perhaps fully effectual in the latter—On such Soils they will not therefore obviate the occasional Use of Summer Fallowing—May sometimes lessen the Necessity of its being employed—Without this Process many useful Products could not probably be formed in the Soils, so as to promote Vegetation—Green Crops are however necessary to be cultivated as much as possible with the View of keeping Stock—Sorts of Plants most useful on, in this Way—Ruta Buga—Cabbages—Beans—Peas—Clover—From the great Varieties in such Soils, Differences in the Use, Repetition, and Modes of Fallowing, may be necessary—These should be attended to by the Agricultor—Methods of performing it should be varied according to Soil and Circumstances—Modes of, in different Cases, described—How full Pulverisation may be best effected in—Properest Times of performing the different Ploughings—Different Methods in which they may be done with the most Advantage in respect to the Aëration of the Soils—Weeds may be usefully collected in some Cases—Ploughings asserted by some to be only necessary—Difficult in some Cases to prepare stiff Soils in this

Way—Their Cloddiness prevents the Root Weeds from being destroyed—Only effectually destroyed by the Pulverisation of frequent Horrowing and Rolling—Picking off the Weeds sometimes practised after—This Method economical, by rendering fewer Ploughings necessary—Frost more powerful after—Little Danger of such Soils being made too fine—This proved by Experiment—Other Methods of Fallowing that have been recommended too intricate to deserve the Attention of Farmers—What necessary to be regarded in the Application of Manures after, in different Cases—This sometimes wholly unnecessary—Frequently found more useful for the second Crop after—Reasons why the Cultivation of full green Crops may often be more useful—Depends probably on several Causes—Summer Fallowing may be much lessened by this Means—Why they seem to improve the Land more than light poor Crops—Land always left more fine and mellow after large green Crops are grown—Hence more advantageous to the Cultivator than naked Fallows—Should be more frequently introduced both on light and heavy Soils—Are admissible on the latter more frequently than is in general supposed by Farmers—How best managed on—Observations on green Fallows in general.

IN the preparation of land for the reception of grain or other sorts of crops by repeated ploughings, or the frequent exposure of new and fresh surfaces to the action and influence of the atmosphere, a variety of alterations and changes are produced in the earthy as well as other kinds of materials that enter into the constitution of the soils. The heavier or more earthy particles of the land, by being under different circumstances of the air and seasons thus frequently stirred and turned over, are so effectually divided or separated from each other, and broken down, that even in most of the stiffer sorts of ground, as well as those of the lighter kinds, there is a degree of pulverisation and mellowness effected that could scarcely have been induced by any other means; in consequence of which, the portions of vegetable matter that are present, and that may have been reduced into the carbonaceous state, with the calcareous, the argillaceous, and other earthy ingredients, and such metallic substances as may exist in the condition of oxyds or calces, become so uniformly and so extensively blended and incorporated, and the manures that are afterwards applied so minutely intermixed with them, that the fibrous roots of the growing crops, of whatever nature they may be, are enabled to penetrate and extend themselves more fully, and of course to draw more regular and varied, as well as more abundant, supplies of nourishment.

Besides, on account of the extreme division and pulverisation that takes place, and the great irregularity of surface which is produced in this way, the dews and light refreshing rains that are so frequently occurring in the early spring months, are more capable of being admitted and diffused through and detained in the hollows and interstices of the ground, and thus to contri-

bute powerfully to the ſupport of the crops in the more incipient ſtages of vegetation.

By the repeated turning-in and deſtruction of different ſorts of plants of the weed kind, much vegetable mucilaginous and ſaccharine matter may alſo be added, as well as the land improved by the putrefactive fermentation that muſt from theſe cauſes be conſtantly taking place.

There are alſo other modes in which advantages may be gained by the repeated turning-over and breaking-down of the particles of ſoils, as from much of the atmoſpheric air being by ſuch methods of huſbandry blended with the fine particles of the ſoils, and detained in the numerous hollows and cavities formed by ſuch degrees of pulveriſation, a larger proportion of oxygen may be ſupplied, which by its union with the carbon and other inflammable materials that are moſtly contained in ſoils, may produce the carbonic or other acids, according to the circumſtances of the caſes, in greater abundance, and in this manner aid the growth of vegetables in a high degree. And as the water or moiſture that is included in large quantities in the pores of ſoils in ſuch powdery ſtates, may undergo the proceſs of decompoſition more fully, by coming more minutely in contact with the portions of atmoſpheric air that are covered up and impriſoned with it in them, the ſupplies of ammonia or volatile alkali, by the combination of its hydrogen with azote, may be more regular and more copious, as well as thoſe of nitre, by the more complete union of its ſuperabundant oxygen with ſome other portion of the abounding nitrogen or azote of ſuch air *.

It has likewiſe been ſuggeſted, that as the atmoſpheric air conſiſts, or is conſtituted of oxygen, azote, and the fluid matter of heat, if the heat that cauſes them to exiſt uncombined in the form of gaſſes be drawn away from them by ſome other material while they are confined in the cavities of the ſoil, they may by their nearer approach to each other combine ſo as to produce nitrous acid; or the oxygen, in its fluid ſtate, not in its aërial one, may more readily unite with carbon, and thus conſtitute a fluid, not an aërial carbonic acid, which is ſuppoſed to be of great utility in promoting the growth of plants. And further, that if any proceſs of the putrefactive kind be going on where atmoſpheric air is in this way confined in the interſtices of the ſoil, and by the deprivation of its heat is converted from a gas to a fluid, the azote may combine with the hydrogen of the decompoſing water, or contribute to decompoſe it, and in this manner form volatile alkali, which, like nitrous acid, may, either during the proceſs of its formation, or after that has been completed, be of very material utility in pro-

* See Darwin's Phytologia, p. 283.

moting vegetation, while at the ſame time the oxygen afforded by the decompoſing water may, like that of the atmoſphere, contribute to the production of the carbonic, nitrous, or phoſphoric acids; and in this way render carbon, phoſphorus, and the baſis of nitre, capable of being taken up by the abſorbent roots of growing plants. From the great diminution of bulk that has been found from experiment to take place where atmoſpheric air is confined in contact with water, it is conceived that there may be a decompoſition of both the water and the air, and a production of both ammonia and nitrous acid, which are known to be beneficial in promoting vegetation *.

In theſe different views the practice of fallowing may in various inſtances be highly beneficial, notwithſtanding the objections that have been ſo repeatedly brought againſt it by writers on huſbandry; but at the ſame time it muſt be admitted that in ſome ſorts of ſoil it will, for ſimilar reaſons, be much more advantageous and uſeful than in others. On the lighter kinds of land, where full and luxuriant crops of different ſorts of plants, as turnips, potatoes, &c. may be grown, that produce a cloſe, thick foliage, and which, as has been ſhewn by experiment †, afford under ſuch circumſtances much carbonic acid, which, from its being greatly heavier than the common air of the atmoſphere, muſt fall upon and be mixed with the ſoil in ſuch ſtagnated ſituations, and thus, together with the more conſtant moiſture that muſt be preſent in ſuch caſes, promote the ſolution and decay of various vegetable matters, and continually add carbonaceous and other materials ſo as to greatly improve the ſoils, it can but ſeldom be neceſſary. Beſides, as in theſe ſoils, by the uſe of the drill, and repeated hand or horſe hoeing during the growth of the crops, the ground may be kept perfectly clean from weeds, and in a fine mellow or powdery ſtate, without the danger of being injured by too much evaporation and expoſure in the way of fallowing; and likewiſe in ſoils of the ſame nature, that are rich from the frequent applications of manure, and in which the proceſſes by which the different nutritious ſubſtances that have been deſcribed are formed and prepared, are properly going on, it muſt be injurious and improper to expoſe their ſurfaces frequently to the influence of the air, ſun, and rain, as is the caſe in fallowing, as by ſuch means the portion of carbonic acid that may exiſt in the ſtate of a fluid, may be made to aſſume the gaſſeous form, and be more readily diſſipated, as alſo the phoſphorus and the other materials in their different conditions before they form nitrous acid or

* See Darwin's Phytologia, p. 284.

† See Prieſtley's and Ingenhouſes's Experiments on Air.

ammonia. Thus, befides the injury that may be done in fallowing fuch forts of land, by the carbon and other inflammable materials which they contain, combining with the oxygen of the furrounding atmofphere, and afterwards by their further union with other fubftances fo as to form infoluble compounds, fuch as phofphat of lime and calcareous nitre, as has been ingenioufly fuggefted by an intelligent writer *, there may be others of not lefs confequence arifing from the diffipation and lofs of the carbonic or nitrous acid, or of volatile alkali in the gaffeous ftate †.

But in all the wet-bottomed, ftiff, adhefive, and clayey forts of foil, which conftitute a large proportion of the lands of the kingdom, where, from the clofenefs of their textures, and the great tenacity of their particles, but a very flight, or indeed fcarcely any degree of pulverifation has been effected, the practice of fummer fallowing may often be highly ufeful and advantageous, not only by the great mechanical alterations that muft of neceffity take place in them by the repeated ploughing or turning up of their parts to the influence of the atmofphere, but by their admitting the particles of the manures that may afterwards be applied, to be blended and incorporated with them in a more minute and extenfive manner; and their becoming fo perfectly aërated as that the different proceffes, that have been mentioned, may take place and properly proceed, fo as to form in them fuch fubftances as have been found of utility in aiding the growth of crops; and which could not poffibly have been produced without fuch pulverifation as is the effect of fallowing.

The degree of friability and mellownefs that is produced in this way in fuch foils, has alfo other advantages, fuch as thofe of admitting the roots of the growing plants to penetrate them with greater facility, and prefenting a more extenfive furface for them to draw their nourifhment from.

And as in lands of thefe kinds there is a conftant tendency to throw up abundant crops of root and other weeds ‡, it is perhaps only by the frequent turning over of the foil, and the tearing of them up by harrowing, as is the cafe in fummer fallowing, that they can be effectually eradicated and deftroyed. It is principally in this view that the working of fuch foils in the early fpring or fummer months becomes fo particularly neceffary; as at the period in which the feed is to be put into the ground, neither the feafon nor the ftate of the weather

* See Dundonald on the Connection of Agriculture with Chemiftry.

† See Darwin's Phytologia, p. 288.

‡ See Agricultural Survey of the Weft Riding of Yorkfhire, p. 81.

will admit of their being ſufficiently broken down and reduced by ploughing, or the weeds to be deſtroyed. And it may be added, that wet lands, by being turned over during the winter ſeaſon, are liable, in many caſes, to become more ſtiff and adheſive, by which the roots of the crops muſt be more limited and confined in their means of acquiring nouriſhment from them.

It has been lately well obſerved, that "when land of a dry, gravelly quality, gets foul, it may eaſily be cleaned without a plain ſummer fallow; as crops, ſuch as turnips, &c. may be ſubſtituted in its place, which, when drilled at proper intervals, admit of being ploughed as often as neceſſary; whereas wet ſoils, which are naturally unfit for carrying ſuch crops, muſt be cleaned and brought into good order by frequent ploughings and harrowings during the ſummer months *." Indeed it is ſtrenuouſly contended by the ſame author, that the moſt judicious intermixture of crops upon clay ſoils will not preclude the neceſſity of a ſummer fallow; though he admits that it may go a great way in preventing the neceſſity of its being ſo frequently repeated †. But another writer, whoſe experience has been conſiderable, while he allows that there is no queſtion at all of the merit of fallowing when compared with bad courſes of crops, and who thinks, that if the huſbandry is not correct in this reſpect, the fallowiſt will certainly be a much better farmer than his neighbours, contends that there are courſes which will clean the fouleſt land as well as any ſummer fallow, by means of plants which admit all the tillage of ſuch a fallow. "Cabbages," ſays he, "are not planted before June or July: winter tares admit of three months' tillage, if tillage be wanted. Beans, well cultivated, will preſerve land clean, which has been cleaned by cabbages; and in any caſe two ſucceſſive hoeing crops are," he thinks, "effective in giving poſitive cleanneſs. Theſe obſervations are not," he ſays, "theory; they are practice: and it is high time that mankind ſhould be well perſuaded, that the right quantity of cattle and ſheep cannot be kept on a farm, if the fallows of the old ſyſtem are not made to contribute to their ſupport ‡."

There is probably, however, many ſituations of clayey ſoils ſo exceedingly ſtiff and wet, that though turnips, cabbage, or bean crops may be grown upon them, it cannot, from the great labour and difficulty of their preparation, and the high degree of injury that muſt be done in the eating or carrying them off the land, be to much advantage, or ſuch as to admit of that ſort of culture during their growth that will keep the ground perfectly clean from weeds. In

* See Brown's Agricultural Report of the Weſt Riding of Yorkſhire, p. 81.

† See Young's Agricultural Survey of the County of Suffolk. ‡ Ibid.

ſuch caſes no courſe of cropping, however judicious, can probably be effectual in this reſpect: it is indeed well known to ſuch practical farmers as have had the management of ſoils of this nature, that it is ſcarcely poſſible to be effected even by ſummer fallowing itſelf. It has alſo been juſtly obſerved, that ſoils of this deſcription are ſo frequently from neceſſity ploughed over when wet, that an adheſion and ſourneſs is produced that cannot be removed without expoſure to the heat of the ſummer's ſun, and the pulveriſation afforded by the repeated operations of the plough and the harrow. There is no ſort of crop that can in ſuch caſes ſupply the place of fallow, as turnips are highly detrimental; and drilled beans, though they may anſwer in the way of an aſſiſtant to fallow, and have the tendency of keeping lands clean that are already in a proper condition, it is ſuppoſed, from the neceſſity there is of ſowing them early, that they can never be beneficially ſuſtituted for the radical improvement that is produced by a clean ſummer fallow *.

But even if ſuch ſorts of land could be kept perfectly clean and free from weeds by the judicious interpoſition of bean, cabbage, or other ſimilar crops that might be cultivated on them, it is evident that the various beneficial products which have been mentioned, and which are the reſult, in a great meaſure, of the perfect pulveriſation and high degree of aëration that is produced by means of ſummer fallowing, could never be formed in ſuch an abundant manner as to be of much utility in aiding the growth of crops. Nor could they be in ſo ſuitable a condition for the admiſſion and extenſion of the abſorbent roots of the plants that may be cultivated upon them.

Yet though theſe circumſtances may demonſtrate the practice of fallowing to be occaſionally neceſſary and highly uſeful on ſuch wet, adheſive, clayey ſoils; as the proper and moſt advantageous quantity of ſtock for the improvement of ſuch farms can ſeldom be kept where it greatly prevails, the repetition of the practice ſhould, in this view, be prevented as much as poſſible, by the cultivation and growth of green crops as often as the lands may be in a ſtate fit for them, and they can be had recourſe to with any chance of ſucceſs. The *Ruta Baga*, or Swediſh turnip, as being a plant ſomewhat more adapted to wet, ſtiff ſoils, than either the common cabbage or turnip, might probably in ſuch caſes be advantageouſly ſubſtituted as a green crop, and by being eaten off in the later ſpring months, when the ground became ſufficiently dry to bear the cattle or ſheep without injury, admit of a pea crop: after which the land would proba-

* See Brown's Agricultural Survey of the Weſt Riding of Yorkſhire, p. 88.

bly be in a fuitable condition for wheat; or a crop of clover might be taken, and then wheat. But in all fuch cafes much muft depend upon the degree of cleannefs, pulverifation, and aëration, that has been accomplifhed by the occafional ufe of fummer fallowing.

As there is much variety in the conditions of fuch foils as may occafionally require the aid of naked or fummer fallowing, in order to render them fuitable for the growth of clean grain or other crops; fome from the nature of their fituation and the fub-foils on which they are placed, being more inclined to the retention of injurious moifture or wetnefs than others, confequently more difpofed to be cold, and to the throwing up of large crops of weeds; while others, from the large proportion of clayey or tenacious loamy materials that may be mixed and incorporated with the pebbly or other ingredients, may be more ftiff and retentive, and of courfe more difficult or more incapable of fufficient pulverifation, and of admitting the roots of fuch plants as are capable of being cultivated upon them, to readily eftablifh themfelves and draw from them proper fupplies of nourifhment. And befides the varieties of thefe different ftates, there may probably be others that have not hitherto been well afcertained or attended to, fuch as may proceed from the differences in the qualities or properties of the clays or loams as they enter into or exift in their compofitions; upon each of which fome diverfity in refpect to the neceffity, repetition, or method of conducting the bufinefs of fallowing, may depend. The correct agricultor fhould therefore conftantly keep them in view, whenever it may be requifite for him to prepare land by means of fummer fallowing.

In regard to the method of performing the operation, it fhould always, like moft other proceffes in hufbandry, be conducted with a due attention to the circumftances and qualities of the foil, as more pulverifation or breaking down will evidently be required where the land approaches to the nature of a perfect clay, than where it has more of the loamy quality; and where the retention of moifture is confiderable, more regard will be neceffary to the deftruction of weeds, than where there is a greater tendency to drynefs. In moft cafes where the practice of naked fallowing is thought neceffary to be performed, the moft general method of proceeding is, for the land to be firft ploughed up in autumn, a fecond time after the barley feed-feafon is finifhed, and two or three times or oftener afterwards, as circumftances may render neceffary; the ground being well broken and reduced by means of harrowing in the intervals of the different ploughings. But it has been obferved, that "in many diftricts feldom more than three ploughings are given to lands in a courfe of fummer fallow; one in

autumn, or early in ſpring; another during the ſummer; and afterwards the ſeed-furrow. This preparation appears, however, it is further ſaid, extremely defective; as in an ordinary ſeaſon it is ſcarcely poſſible that with ſo few ploughings either the root or ſeed weeds can be completely deſtroyed; and when the ſummer happens to be wet or rainy, the lands under ſuch management muſt certainly be in a very bad ſtate for receiving the ſeed*.

It has likewiſe been long ſince judiciouſly recommended, both in the preparation of lands by winter fallowing for barley crops, and ſummer fallowing for thoſe of wheat, that when it is firſt ploughed up after the harveſt is over (which ſhould always be done as deep as poſſible), no time ſhould be loſt in rendering the new-turned-up ſoil as fine as poſſible by harrowing; as repeated trials and attentive obſervation have fully ſhewn, that ſuch lands as are made fine before the ſharp froſt and winter rains come on, receive a much larger ſhare of their influence than any others. But that if the land be left in a rough ſtate, there is ſeldom time for the rains and froſt to penetrate or affect more than merely the outſide of the large clods or lumps that are preſent. The outſide may thus, indeed, be pulveriſed; but the middle of the lumps, wherever they are large, are found nearly in the ſame hard, ſtiff ſtate, as when turned up by the plough. Hence it is evident that the benefit of the air, winter rains, and froſts, on lands thus left, muſt be only partial; and that of courſe the harrowing it in the ſpring, eſpecially when the latter of theſe are over, is too late for its receiving the full benefits which might otherwiſe have accrued from them, and the power of promoting vegetation not being nearly ſo great. Therefore to make winter fallows as fine as poſſible in autumn, and then ridge them up in that pulveriſed ſtate, is acting moſt agreeably to nature; the greateſt poſſible quantity of ſurface being thereby expoſed to the atmoſphere, and the land left in the ſtate wherein the rains and the froſts are moſt eaſily admiſſible: they are conſequently more capable of penetrating and enriching the whole maſs to a much greater extent.

By this means too, a larger proportion of atmoſpheric air is involved and incorporated with the mold, and of courſe a more perfect degree of aëration effected. It is contended, that it has been invariably found that the froſt penetrates a quantity of earth, formed into a large hard clod, only partially, on account of its bulk and hardneſs, and that the ſame clod, broken into four parts, would be thereby penetrated four times as much; or, in other words, that four

* See Donaldſon's Modern Agriculture.

times the quantity of earth would be affected, and on a thaw be pulverifed by it. For it is always found, after the breaking up of a fevere froft, that all the fmall clods crumble eafily into powder, while the large ones are only flightly reduced by the crumbling off of a portion of their external furfaces*.

There cannot be much doubt but that by reducing fuch ftiff, adhefive foils, as require fallowing, well on their being firft ploughed up, great advantages in the way of pulverifation may be accomplifhed, as in the fpring and fummer months they are apt to cake, and become fo hard and lumpy as to be wrought with difficulty.

In order to fully afcertain the utility of this method of preparing fallows, one half of a field of ten acres was left as nearly of an equal quality as poffible, in the rough ftate after ploughing; while the other was made very fine, by harrowing and beating in pieces any large hard clods which the harrows could not reduce. In the following fpring it was obferved, that that part which had been harrowed was much finer without any additional working than the other could be rendered by repeated harrowings †.

It is therefore evident, that upon moft forts of ftiff, clayey foils, where fallowing becomes neceffary, the firft ploughings fhould be given if poffible before the commencement of the winter feafon, and that they fhould alfo be well reduced by means of harrowing, in order to promote the decay of fuch vegetable matters as may be upon the furface of the land, as well as to promote a more complete ftate of pulverifation and aëration of the foil. This is often moft ufefully performed by gathering up the ridges, as in that way the ground is not only laid more dry, but the furrows more effectually opened for the draining off of the injurious moifture. In the fecond ploughing in the fpring, which is generally before the crofs-ploughing is given, thefe ridges ought to be cloven or turned back again, and, after laying a fuitable length of time, be well harrowed for feveral times, and occafionally rolled, that fufficient opportunity may be given to collect and remove every fort of weed that may be brought up to the furface. After this bufinefs has been properly performed, the land may be again ridged up by means of the plough, by which it is rendered lefs affected by wetnefs, and the portions of foil that had not been touched in the crofs-ploughing ftirred. In this way a perfectly clean fallow may foon be produced. It has, however, been maintained by fome writers who have had much opportunity of examining the matter, that ploughing only is neceffary; the collecting the roots of the weeds and removing them being ufelefs and im-

* See Letters and Papers of the Bath Agricultural Society, vol. II. † Ibid.

proper. But in the ſtiffer ſorts of clayey, wet ſoils, where we have conceived the fallowing ſyſtem to be chiefly occaſionally neceſſary, it is almoſt impoſſible to get perfectly clear of different ſorts of root weeds in this way, from the cloddy manner in which ſuch lands break up in the operation of the different ploughings, the earthy lumps often containing many that are not in the leaſt degree injured in their power of taking root, by the heat to which they may have been expoſed in ſuch ploughings. In theſe caſes, they can only perhaps be effectually eradicated and deſtroyed by the high degree of pulveriſation that may be accompliſhed by means of frequent harrowings and rollings; the weeds being afterwards carefully removed by the hand*. In this way there may alſo frequently be a conſiderable ſaving of expence by the leſſening of the number of ploughings. The froſt in the winter months has alſo, as has been ſeen, a much more powerful action where ſuch reductions in the clods of ſuch ſoils have been effected. In ſuch ſoils there can ſeldom be any danger of their being made too fine by operations of this nature, as the ſeed furrow, when given ſufficiently deep, conſtantly leaves the land lumpy and irregular enough for the purpoſes of covering the grain and protecting the young plants during the ſeverity of the winter ſeaſon †. The benefits of affording as high a degree of pulveriſation or fineneſs as poſſible to the land in the management of this proceſs, has been fully ſhewn by the reſults of well-conducted experiments. The produce of a field of barley and broad clover, one half of which had been prepared in the moſt perfect mode of fallowing, and the other half in the common method, on being harveſted and kept ſeparate, was in the following proportions: That which had been conducted in the latter way only affording twenty-four buſhels to the acre, while the former yielded thirty-one, and the grain conſiderably better in quality. There was alſo an equal ſuperiority in the clover crop the ſucceeding year, that on the moſt perfectly-prepared part being heavier by nearly half a ton on the acre ‡. In addition to this, it cannot have eſcaped obſervation, that in large fields of wheat, where from accident or other cauſes ſome portions of them have received more frequent ploughings than others, that in theſe parts

* As it is difficult in ſome inſtances to get quit of the weeds and other traſh that may have been brought together by this means, it is probable, that by mixing cauſtic or quick lime with them, when it can be readily procured, in the proportion of three or four buſhels to ten or twelve of the weeds, frequently turning them over till perfectly reduced, and afterwards adding earth and dung, a good compoſt might be formed.

† See Agricultural Report of the Weſt Riding of Yorkſhire.

‡ See Letters and Papers of the Bath Agricultural Society, vol. II.

the crops generally appear for a great length of time more perfect and promifing than on the other parts.

But befides thefe, other methods, efpecially in ploughing up uncultivated lands with a view to fallowing and rendering them more regular and proper for cultivation, have been propofed by writers on hufbandry; but they are either fo imperfectly reprefented as fcarcely to be comprehended, or of fuch difficult execution as not to deferve the notice of the practical agricultor.

In cafes where manure is neceffary to be applied to land after it has been prepared by the procefs of fummer fallowing, it fhould be done according to the nature of the manure and the circumftances of land in refpect to richnefs and the ftate of its tillage. Lime or marle are generally laid on with the greateft benefit during the fummer months, as about the middle of July or the beginning of Auguft; in which cafes it fhould be fpread out as equally as poffible over the land, and ploughed in with a very flight furrow, fo as only juft to mix and incorporate it with the mold; as by this means, where farm-yard manure is applied at the time the feed furrow is given, in a fimilar manner, the calcareous and vegetable manures, by being thus more uniformly blended with the foil, as well as by their more extenfive operation on each other, afford more abundant and regular fupplies of nourifhment to the crops during the firft ftages of their growth, and a degree of heat may be generated that is highly favourable to fuch ftates of vegetation. That fome advantage is afforded in this way is evident, from the rapid growth and great verdure that generally takes place where fallows have been managed in this manner.

In fome cafes of land after fallowing the application of manure may, however, be wholly unneceffary, as from the great deftruction of weeds, and the advantages produced in the different ways that have been mentioned, fuch improvement may be given as to endanger the firft crop by rendering it too luxuriant, and confequently liable to be lodged before it becomes ripe, if manure be applied the fame feafon. Very ftrong crops of grain have, indeed, frequently been produced on fallowed lands without the fmalleft quantity of manure having been put upon them*. Further, it has been afferted, that even lands that have been confiderably exhaufted by improper cropping, have been found to afford a much better crop in confequence of a fallow, without the application of any dung, than from a complete dunging without a fallow†.

* See Agricultural Survey of Mid-Lothian.

† See Communications to the Board of Agriculture, vol. II.

In fuch inftances, therefore, it will be more economical and advantageous to make ufe of the dung with a view to the fecond crop that may be cultivated on the land, and not that which immediately follows the fallow.

Though the advantages that have been ftated to arife from the perfect pulverifation, aëration, and cleannefs, occafioned by fummer fallowing, in thofe foils where it has been found to be occafionally requifite, can feldom be fo fully obtained by other methods of cultivation; yet as that method is conftantly attended with a heavy expence to the farmer, and as many of the benefits that are produced by it may be effected by the repeated partial fallowings that muft occur in the hoe-culture of different forts of crops, it fhould be conftantly the aim of the agricultor, where the climate will admit of it, to leffen the neceffity of fummer fallowing, even on the wet clayey as well as the light kinds of foil, by the judicious interpofition of fuch forts of clofe, thick, green crops, as can be grown and cultivated on them under the hoe fyftem. This is ftill more neceffary, on account of the lofs that muft be fuftained from the land often remaining fuch a great length of time totally unproductive where the fallowing procefs is going on. It cannot, indeed, be difputed, but that the practice of fummer fallowing may be greatly leffened in many diftricts by the proper fubftituting of green fallows, or what are termed fallow crops, fuch as beans, peas, cabbages, tares, and rape, for the heavier forts of land; and buck-wheat, potatoes, and turnips, for fuch as are of the lighter kind *. It is likewife maintained as a fact, that where large and luxuriant crops of thefe preparatory kinds are grown, thofe by which they are fucceeded the following feafon are for the moft part ftill larger, fo that the lands are more improved by large crops than fuch as are poor. This amelioration or increafe of fertility has been attributed to different caufes: as the prevention of evaporation from the foil by the fhade produced by fuch large crops; the putrefaction of the various vegetable matters, which may be more abundant after fuch large crops, taking place more completely and more effectually under fuch circumftances; and laftly, to the repeated pulverifation and aëration that is produced by the different hoeings: but it is probable that advantages may be derived in each of thefe ways, as well as from the carbonic acid or fixed air that is afforded by the fhaded leaves of the plants being depofited upon or united with the foil. That the melioration in fuch cafes muft depend on caufes of this kind there can be little doubt, as much of the nutri-

* See an interefting correfpondence on fallowing heavy foils, in the Appendix to the fourth volume of Wight's Prefent State of Hufbandry in Scotland.

tious properties of the land muſt obviouſly have been conſumed during the growth of ſuch crops, which muſt have been again reſtored to it by ſome ſuch proceſſes.

But in whatever manner this effect may be produced, as it is conſtantly found that land is in a better condition, and, when turned up, in a more friable and mellow ſtate after ſuch crops as are large, than thoſe that are poor and light; it is of courſe evident, that if ground can be covered with ſuch ſmothering crops of the fallow kind, or thoſe that will admit of frequent pulveriſation by means of the plough or hoe, ſo as to keep it clean and free from the growth of uſeleſs plants, it may be more beneficial to the agricultor, not only for the ſake of the immediate crop, but alſo on account of the increaſe of manure produced by ſuch means, and the advantageous condition of the land for the reception of ſuch crops as may be afterwards cultivated upon it *. In theſe different views, as well as thoſe that have been already mentioned, the introduction of green crops of ſome ſort or other ſhould probably be more frequently attempted on all deſcriptions of ſoils; and it would ſeem probable, that on the ſtiff and heavy kinds of ſoil—from its having been found, that in many well-cultivated diſtricts, by the growing of proper leguminous crops in drills or rows, ſo as to admit of the ground between them being frequently ſtirred, either by means of the plough or the hoe, ſuch kinds of land, after they have been once well cleaned by a ſummer fallow, may be kept perfectly clean and in ſuitable tilth for the production of good grain crops—they may be much more generally had recourſe to than has commonly been the caſe: but on ſuch ſorts of land great attention is neceſſary to introduce ſuch kinds of green crops as are adapted to them, and that as little injury as poſſible be done by the treading of animals in the feeding them upon or taking them from the ground. But as neither the full effects of pulveriſation or aëration, nor the complete deſtruction of root weeds, can in ſome caſes be ſo perfectly obtained by the cultivation of fallow crops as by the making of ſummer fallows, it may be advantageous to the agricultor to have recourſe to them occaſionally with theſe intentions on the heavy and more wet ſorts of land, as well as thoſe that have been injured by improper methods of cropping.

* See Agricultural Survey of the North Riding of Yorkſhire.

SECTION XI.

Cultivation of Arable Land.

CULTIVATION OF ARABLE LANDS---*Confidered in Regard to thofe that have not been under the Plough, and fuch as have been in a State of Tillage—In the firft Sort many preparatory Operations neceffary to be performed.*—REMOVAL OF VARIOUS OBSTRUCTIONS TO PLOUGHING—*Stones—Different Kinds of—How beft performed—Neceffity of in different Cafes explained—May frequently be converted to ufeful Purpofes—Land Proprietors fhould be at Part of the Expence of.*—CLEARING FROM WOOD—*Different according to Circumftances—How performed in Trees of the Timber Kind—By trenching with the Spade—By the Plough—When the Roots have been fomewhat removed, a Crop may be taken—Afterwards more effectually cleared—Moftly a better Practice to do this at firft—Reafon of which explained—Manner of in Plants of the fhrubby Kinds—Different Plants prefer different Sorts of Soil—Broom—Bramble—Furze—Thorn—Dwarf Willow—Soils on which each grows moft luxuriantly defcribed—Alteration of, by the Application of fuitable Subftances, how advantageous in deftroying them---Subftances to be applied in this View—Methods of extirpating them when grown large—The Practice of burning in the furze Kind to be avoided as much as poffible—Neceffary to keep fuch Lands in Tillage till there is Time to fully deftroy them—When laid down to Grafs, moft beneficial to be paftured with Sheep.*—HEATH—*Nature of the Land on which produced—Affords lefs vegetable Matter for Improvement of than other Plants—On this Account lefs friendly to the Growth of ufeful Crops—Practices to be adopted in removing it, and in bringing the Ground into Tillage—By cutting—By paring and burning---By burning only—What neceffary to be attended to in each—Implements moft ufeful in cutting it—Lime neceffary to be applied to in its cauftic State—In large Proportions—Mr. Young's Opinion of—Manner of doing it—Should be in a fine powdery State, and equally fpread out—Soon produces beneficial Effects—Methods in which they are effected—Tillage neceffary after—Cafes in which it may be deftroyed without breaking up—Modes of cropping on in different Inftances—Principal Object in, to be laid down to Grafs—Green Crops to be eaten off, effentially neceffary to—Kinds of moft ufeful in different Cafes—Turning down green Crops fometimes practifed on—Not fo ufeful as feeding them on the Land—Cafes in which it may be employed—Should be returned as foon as poffible to Grafs—Other*

Deſcriptions of Land approaching to this—Such as are productive of Ruſhes and other coarſe Plants—Of ant, mole, or other ſorts of Hills—Much Effect produced in the firſt Kind by draining—Utility of paring and burning in—Other Modes ſuggeſted as more advantageous—Mixing the turfy Surface with cauſtic Lime ſuppoſed a leſs waſteful Plan—Reaſon why it may in ſome Caſes be uſefully employed---Ant-Hills may be mixed in the ſame Way---Proportion of Lime ſhould not be too great---Method of by the Flay-Plough ſometimes very uſeful.—STIFF, WET, CLAYEY SOILS—*Modes of Tillage in—Deep ſtirring often neceſſary—This often effected by the Miner—Doctor Anderſon's Opinion of its Utility---Manner in which it drains the Land---Other Modes of accompliſhing it deſcribed---Manner of rendering ſuch Soils mellow and fine by Lime---The Neceſſity of paring and burning leſſened in this Way---Paring and burning muſt be employed in old, tough Swards, abounding with rough Plants---Repeated ploughing frequently neceſſary in breaking up Waſtes---Different Intentions of---Nature of Soil, Climate, Kind of Crop, and Method of ſowing to be conſidered in---Manner of levelling the Land---Implements employed in---Kinds moſt uſeful.*—MANNER OF BRINGING BOGGY LANDS INTO TILLAGE—*Crops moſt proper for.*—DEEP MOSSY SOILS—*Methods of cultivating them—By floating the Moſs---By the Application of Lime without floating---Caſes in which they may be moſt beneficially employed---Methods that have been followed in Scotland mentioned---Method of applying the Lime on---Quantity made uſe of---Manner of ſowing the Crops on---Crops moſt proper to be cultivated on—Cloſe thick green ones moſt ſuitable—Potatoes—Turnips—Rape—Grain Crops—Proper Sort of for—Graſs Seed—Kinds of proper for—Methods of Tillage in deſcribed.*—RIDGES—*What neceſſary to be attended to in forming of—On clayey Soils—On loamy Soils—On marſhy Land—On ſandy and gravelly Soils—On peaty or moſſy Soils—Ridges in moſſy Soils moſtly formed by the Spade—Manner of performing the Work in—May be increaſed in Breadth in deep Soils of this Kind—General Direction of in all Sorts of Soils—North and South the moſt proper—Methods of forming them in hilly Lands—Advantages of in different Caſes deſcribed—Altering Ridges on old cultivated Lands—What neceſſary to be regarded in—Modes of performing in different Inſtances—By the Spade the moſt perfect—By the Plough more expeditious—Mechanical Contrivances diſadvantageous in—Expences of in different Ways—Other Modes of levelling Ridges deſcribed—The Plough ſhould be moſtly employed for.*—PLOUGHING—*Circumſtances to be attended to in performing of—In heavy Soils—In light Soils—Depth of in different Caſes—Frequency of ploughing different according to the Soil—Repeated Stirring in general more neceſſary on the ſtiff and heavy Soils, than thoſe of the lighter Kinds—On Soils long in Tillage generally leſs neceſſary—For drilling Land ſhould always be in a fine State of Tillage—Nature of Crops moſtly directs the Frequency of ploughing Lands—Some Sorts demand more Tillage than others—A fine State of Tilth generally favourable—Tull's Opinion of Tillage in general—Crops liable to be much injured by Weeds, ſhould always have Land well prepared by Tillage—May often be done by the growth of Plants that demand frequent Culture while growing—By ſuch as have large Roots of the tup or knobby Kind—Reaſons why Land in a fine State of Tilth is moſt favourable to Vegetation—Implements of the Plough Kind moſt proper for performing the Buſineſs in different Sorts of Land deſcribed—Suffolk iron Swing-Plough—The Rotheram Plough—Small's Plough—Importance and Advantages of Ploughs being properly*

conſtructed.—HARROWING—*Different Utility of—Kinds of Harrows to be employed in different Caſes—Manner of being made uſe of in—Drags—Scufflers—Scarrifers—Cultivators—Fixed Harrows often uſeful in preparing Land—Methods of harrowing to cover the Seed in different Caſes deſcribed—Proper Seaſon of performing the Buſineſs in different Soils—Particular Manner of accompliſhing the Work in wet, poachy Soils—Diſadvantage of this Mode ſtated—How performed when Graſs Seeds are ſown.*—ROLLING—*Utility of in different Views—In the Way of breaking down the Lumpineſs in heavy Soils—In light and porous Soils—How it proves uſeful in deſtroying Weeds, and rendering the Land level—Kinds of Rollers moſt uſeful for different Purpoſes.*—MANURING OF TILLAGE LANDS—*Intentions of in different Inſtances—Kinds of Manure proper for in different Caſes—On heavy Soils—On thoſe of the middle Sort—On marſhy Soils—On light Soils—On moſſy or peaty Lands—Methods of applying with moſt Advantage upon each—Nature of the Crop to be attended to in—Reaſons of explained.—Proper Modes of laying on for particular Sorts of Crops—Modes of performing the Buſineſs under different Methods of Culture—Manner in which Manures ſhould be chiefly employed—Depths to which depoſited—Quantities in which made uſe of—Seaſons in which beſt applied—Sheep-folding—Modes of performing it—Where moſt uſeful in this View—Green Crops—Utility of in this Way.*—SOWING—*Modes of preparing the Seed—Neceſſity of in different Views—Utility and Advantage of in various Inſtances—Change of Seed ſometimes neceſſary—Reaſons of—Broadcaſt, or what is commonly termed the old Method, deſcribed—Where capable of being practiſed with Advantage—Other Methods more uſeful in ſome Caſes—Drill, row, or what is called the new Method, explained—This probably older than the other—Where capable of being employed to moſt Benefit—What neceſſary in—Implements moſt ſuitable for—The Advantages of each Method ſhewn—Comparative Statements of under different Circumſtances—Culture neceſſary in each Method during the Growth of Crops—Hoeing—Kinds of Implements moſt proper for in different Caſes—Weeding—Implements proper for.*—ROTATION OF CROPS—*Importance and Utility of—Thoſe moſt proper in different Sorts of Soils.*—CROPS—*Particular Methods of cultivating various Sorts of—Wheat—Rye—Barley—Oats—Beans—Peas—Potatoes—Turnips—Cabbages—Carrots—Parſnips—Cole or Rape—Hemp—Flax—Methods of harveſting, ſtacking, managing, and preſerving the various Kinds of—Manner of threſhing them out—By the Flail—By the Threſhing Machine—Advantages of each Method.*—ARATION—*Lands moſt proper for explained—Laying them down to Graſs—Beſt Mode of doing it in different Caſes ſhewn—Should always be in a fine State of Tilth for—Modes of Preparation neceſſary for—Groſſes moſt ſuitable to in different Caſes of.*—GRASS CROPS—*Of the artificial Kinds—Proper Culture of thoſe raiſed by the Plough—Clavers—Trefoil—Saintfoin—Lucern—Tares—Vetches—Checony, &c.*

IN explaining the methods of management that are neceſſary in the cultivation of arable lands, in order to afford a ſuitable ſtate of ſoil and nouriſhment for the growth of grain or other crops, it will be proper to conſider them as relating to

grounds that have not yet been brought under the plough, and ſuch as have been already in the ſtate of tillage.

Removing obſtructions to tillage.—In the firſt there are frequently various operations to be performed, ſuch as the removing of ſtones, the eradicating of wood, both of the tree and ſhrub kind, the deſtruction of different ſorts of plants of the aquatic and other denominations, and the removal of ſuch degrees of wetneſs as may be injurious, before the buſineſs of ploughing or looſening the mold of the ſoil can be properly carried on. The ſtones that oppoſe obſtruction, in this view, are principally either ſuch as are met with in a looſe ſtate in the ground on its being ploughed, or ſuch as are fixed in the ſoil, and incapable of being removed without much labour and difficulty. Some of theſe laſt are often of ſuch a ſize as to preſent themſelves upon the ſurface, and cauſe much land to be loſt, by their not permitting the plough to come near them *. Thoſe which are concealed below the ſurface are, however, the moſt detrimental, as the implements are frequently deſtroyed, and much inconvenience experienced from them, before they can be perceived by the ploughman, though he may be perfectly attentive to the circumſtance.

In ſuch ſoils as contain no concealed ſtones of the rocky kind, as is the caſe in moſt of the alluvial and deep ones, if any inconvenience be ſuſtained by the ſmall ones that appear on the ſurface after harrowing, as may be the caſe at the time of their being ſown with artificial graſſes, or laid down to permanent graſs, from the obſtruction that may be given to the ſcythe, in ſuch inſtances they may be picked off by the hand before rolling; or forcing them into the ſoil by heavy rolling alone, may occaſionally be ſufficient. When the former practice is adopted, they ſhould not, however, as is the cuſtom in many diſtricts, be collected into heaps, or laid all along in the furrows; as in theſe ways they are afterwards liable to afford much obſtruction, or to become again diſperſed over the land. They ought always to be completely removed: the beſt ſeaſon for doing which is, when the land is in ſummer tillage; as under ſuch circumſtances the buſineſs can be performed with the greateſt convenience, and in the moſt effectual manner. In lands that are of the more wet kinds, they may, however, be collected into heaps of rather a large ſize, in order to be taken away afterwards during a dry ſeaſon. The buſineſs of picking the ſtones is moſtly performed by women and children, and the lands are cleared in this way with much greater expedition than can eaſily be ſuppoſed. Though an inſtance or two has been men-

* They are termed *ſit-faſt* ſtones in ſome counties.

tioned in which injury was ſuppoſed to have been ſuſtained by the removal of the ſmall ſtones from the ground, from the great evaporation of moiſture that muſt neceſſarily take place, and the want of heat and ſhelter for the crops during the early ſtages of their growth, it is probable that much leſs inconvenience will be ſuffered in this way, than from the obſtruction conſtantly afforded by the ſtones in the tillage of the land, and the loſs cauſed by the great extent of ſurface which they occupy in many caſes where they are numerous.

Where the ſtones are faſt in the ground, of a large ſize, and appear above the ſurface of the land, the beſt practice is to dig them completely out of the earth, after they have been blown to pieces by means of gunpowder; but if they be ſmall, it will be unneceſſary to blaſt them, as they may be raiſed, after being dug round, without that expence, by ſplitting them by means of wedges, or breaking them by large heavy hammers, and then conveying them off the land in ſome kind of low, ſtrong carriage *. In clearing fields of large ſtones, a machine has lately been recommended, by which the heavy expence of boring and powder, with the trouble and danger of blaſting, is not only ſaved, but the labour of loading them conſiderably leſſened. Three men, by means of it, being capable of raiſing ſtones to the proper height with more eaſe, expedition, and ſafety, than ten in the common method. It is formed in the manner of a triangle, and has much reſemblance to that employed by wood-cutters in weighing bark †.

* A ſmall portion of quick lime in fine powder, mixed with gunpowder, is ſaid to have been found to leſſen the expence of that article in blaſting-ſtones.

† It conſiſts, according to the author of the Agricultural Report of Perthſhire, of three legs, made of any ſort of hard wood, each about four inches in thickneſs, ſix inches in breadth, and fourteen feet in length; their thinneſt ſides being placed inwards, to give them greater ſtrength. Their feet, when placed on the ground, form an equilateral triangle, and their three tops being fixed together by an iron bolt that paſſes through each of them; two of the legs are faſtened to each other by a windlaſs and three croſs bars. It has two pulleys, with an iron hook two inches in circumference attached to each, and one or more iron chain to paſs round the ſtone while on the ground, below its greateſt diameter, or where it begins to become narrow; this conſiſts of rounded links about three inches long, and of the thickneſs of a man's little finger, with a hook at one end that may be put into any of the links towards the other end, in order that it may embrace the ſtone exactly, and be of the ſame circumference when the ſtone touches the earth. Short chains of the ſame kind, the hooks of which are fixed into the links of the ſurrounding chain, are to be attached all round the ſtone, with their correſponding links fixed on the hook of the lower pulley. The whole of the rope muſt be of the ſame thickneſs with the two great hooks, two inches in circumference.

The machine being thus prepared, two men, by turning the handles of the windlaſs round, and the

The method of ſinking large pits cloſe to the ſtones for concealing them in, is an expedient that ought but ſeldom to be adopted, on account of the danger that attends it, and the total loſs of the ſtone.

But where the ſtones are principally concealed below the ſurface, it will be neceſſary to diſcover their ſituation, either by going over the land with ſome ſort of ſharp inſtrument that can be readily thruſt down into the ground, or to mark their ſituations during the time of ploughing, and afterwards to remove them by digging. In ſome caſes, as where the ſtones are extremely numerous and the price of labour cheap, it may be a more advantageous and economical method to prepare the land by means of the ſpade than the plough *.

In all caſes, land ſhould be as much as poſſible cleared from ſuch ſtones as retard or prevent the operation of the plough before the buſineſs of tillage be undertaken; as without due attention in this reſpect, conſiderable loſs may be ſuſtained by the breaking of implements, and the great delay that muſt take place in the work.

Beſides, in many ſituations and circumſtances, there may be great inducements to have this ſort of work performed; as where hollow or under-draining becomes neceſſary, the rounder ſorts of ſtones may be beneficially employed in filling them, while thoſe that are of a larger and more flat form may be made uſe of in the conſtruction of offices or other buildings, and ſometimes even for the purpoſe of fences. As this work is frequently attended with a heavy expence, it may be proper, where there are no leaſes, or they are of ſhort duration, to have it undertaken jointly between the land-proprietor and the farmer; the former being at the expence of blaſting the ſtones, and the latter at that of their removal from the ground †.

In the clearing of lands from wood, different methods muſt be purſued according to the nature of the wood with which they are covered. Where there are large trees of the timber kind, they ſhould be completely grubbed up at a proper ſeaſon of the year, care being taken that the roots be as much as poſſible removed. In eradicating ſuch trees as have their roots penetrating downwards to ſome depth, as the oak, it may frequently be unneceſſary, after

aſſiſtance of the carter with a lever, force the ſtone up, and hold it at the proper height to be loaded by backing the carriage under it. By this contrivance ſtones of very great weight, it is ſaid, have been raiſed and removed.

* See Headrick, in Communications to the Board of Agriculture, vol. II.; and Anderſon's Agricultural Report of Aberdeenſhire.

† See Gentleman Farmer, p. 59.

the earth has been well removed from about them, to cut more than a few of the ſtrongeſt lateral roots, the reſt giving way by pulling at the top of the tree by means of a rope. But in ſuch as have their roots ſhooting laterally near to the ſurface of the ground, as the elm, the roots muſt be almoſt wholly removed before they can be got up, and the buſineſs of ploughing be properly carried on. In caſes of this ſort, trenching by means of the ſpade, and forcing the roots up by a pick-axe, is recommended by ſome as the moſt effectual method; as in this way the roots are not merely removed, but the land put into the moſt convenient form for future cultivation *. Beſides, when ſuch portions of bruſhwood as may have been collected upon the ſurface of the land have been cut at the ſame time and conſumed with the roots, ſome advantage may be gained in the way of manure, by ſpreading the aſhes over the ground, and in ſome meaſure repay the additional expence that may have been incurred by the trenching. But in moſt caſes, eſpecially where the price of labour is high, we believe the buſineſs may be well enough accompliſhed by a ſtrong plough, with a ſuitable ſtrength of team. After the trees, and as many of the roots of theſe ſhrubby plants as poſſible, have been removed during the time of the firſt ploughing up, the land may be ſown with ſome ſort of crop to which it may be the beſt adapted; and after that has been taken off, be more completely cleared by repeated ploughings and harrowings both lengthways and acroſs the ridges, until the whole are extirpated. Or, when there is time, this may be done before any crop is put into the ſoil; which in many caſes is a method to be preferred, as a good or full crop of any kind can ſeldom be expected till the ground has been perfectly freed from the roots of ſuch trees and plants, on account of their more increaſed tendency, under ſuch circumſtances, to ſhoot up and vegetate afreſh, and thereby injure it by the great ſpace which they occupy, and the ſhade they produce, or where their roots decay in the ſoil, by rendering it too light and open for the growth of moſt ſorts of crops †.

As different ſorts of plants prefer different ſoils—the broom and bramble kind being found to grow with the greateſt luxuriance on ſuch as are of the more dry and ſandy or gravelly qualities; the furze, on ſuch as are dry, but which approach the nature of loam or clay; the thorn kinds, on thoſe that are of a more mellow and leſs adheſive deſcription; and the low willows, on ſuch as poſſeſs conſiderable degrees of moiſture—it may be poſſible in many inſtances to derive great advantages in the removal of ſuch obſtructions to cultivation by the appli-

* See Communications to the Board of Agriculture, vol. II. p. 259.

† See ſection on Paring and Burning.

cation of ſuch manures or other ſubſtances as may produce changes and alterations in the textures or general nature of the foils, and thus leſſen their tendency to the production of ſuch plants. In this view, the application of clayey marle, or compoſts with peat-earth and lime, or loamy and clayey earths and lime, farm-yard manure, or compoſts made with it and mold, night-foil with good vegetable earth, ſand, and various other materials, according to the circumſtances of the foil, the nature of the plants, and the convenience of the ſubſtances in reſpect to their application, may be proper. The removal of ſuperficial moiſture may alſo be uſeful in the ſame way in many caſes.

In caſes where ſuch ſorts of ſhrubs have become of conſiderable ſize, the general method of proceeding is to cut them down as cloſe as poſſible to the ſurface of the ground, and afterwards to dig round them, and grub them up in the manner that the larger trees are cleared. With furze it is ſometimes cuſtomary ſet fire to them, in order to uncover their ſtems before any attempt is made to grub them up; but this is a practice that ought to be as much as poſſible avoided, from the danger that may attend it, and the loſs of the furze, as well as a large portion of the valuable vegetable matter accumulated in many caſes beneath them *.

As it has been found from experience, that ſuch lands as have been attempted to be cleared from bruſhy plants of this kind, eſpecially thoſe of broom and furze, are extremely liable, from the roots and ſeeds that may be left in the foil, to have them coming up again in great abundance after they have been laid down to graſs; it ſhould be a practice to keep lands that are much diſpoſed to their production in the ſtate of tillage for ſuch a length of time as may be fully ſufficient, by the various means of cultivation, and the application and blending of lime and other ſuitable manures with them, to have them as completely removed as poſſible; and that when they are reſtored to the ſtate of graſs, to have them paſtured, as much as can be conveniently done, with ſheep †. It has indeed been obſerved by an intelligent writer, that

* It is obſerved by Mr. Headrick, in a valuable paper in the ſecond volume of Communications to the Board of Agriculture, that a very powerful and uſeful implement for this purpoſe is, a ſtrong lever, ſhod with iron, and having the iron ſhoeing bent a little upwards by a gentle curve. The iron extremity ſhould divide into two prongs, with an edged angle, ſimilar to a hammer for drawing nails: ſuch an inſtrument may, he ſays, be thruſt in below a ſhrub of any kind until it ſeizes its tap root, and by the aid of a ſtone or block of wood, to ſerve as a fulcrum, the ſhrub may be rooted out by one effort.

† Sheep, horſes, and even every kind of neat cattle, are extremely fond of the young and tender ſhoots of broom, furze, and other ſorts of plants in the ſpring months, probably from their juices con-

if whins, or ſhrubs of any kind, are once grubbed up in the way that has been deſcribed, ſheep being then admitted to paſture, would prevent them from ever growing again from the ſmall roots left in the ground. But ſtill more would this experiment, he conceives, be likely to prove ſuccefsful, if the ground were completely fallowed, and every root that appeared, removed. The land, being then well limed and manured, might be ſubjected to a courſe of cropping, and be ſown down with graſs ſeeds without a crop. As ſoon as the graſs afforded a ſafe bite, he would admit ſheep, and not wait for a crop of hay. It is preſumed that ſheep would deſtroy the tender ſhoot of every ſhrub as faſt as it roſe, and keep the ground ever after clear*.

If, however, this practice ſhould not be ſufficient to prevent the ſhrubs from ſending up freſh ſhoots, the beſt method would be to have again immediate recourſe to the plough, and ſuch other means as have been recommended above, as by delay the plants may become too ſtrong to be turned under by the plough.

Heath, which is a ſort of plant that for the moſt part infeſts thoſe ſoils that are of a moory nature, and in which there is but a ſmall proportion of vegetable matter, on account of there being few leaves or other vegetable products, except the heath itſelf, to be converted into mold; the recrements of this plant are not found to afford improvements to the ſoil on which it grows, in the way that is experienced to take place from the decay of many other more ſaccharine, mucilaginous, and juicy plants. Hence it probably is that the heathy ſoils are moſtly ſo poor and unfriendly to the growth of uſeful crops, whether of the grain, leguminous, or graſs kinds. In bringing this ſort of land into the ſtate of tillage—as it has been found from repeated trials, that where the heath is turned down without being removed or completely deſtroyed, it keeps the furrow-ſlices from coming into intimate contact with each other, ſo as that by confining and retaining a due degree of moiſture, the decompoſition and decay of the heath may be quickly effected, and the ſoil of courſe in too open and looſe a ſtate for the growth of almoſt any crop—it ſhould be cut as cloſe to the ſurface of the ground as it can be conveniently done; or what is probably a better practice,

taining a large proportion of ſaccharine matter during the early ſtages of vegetation. Mr. Headrick indeed aſſerts, that a Scotch acre of whins is worth from 3 to £.5, as winter food for horſes and cows, to thoſe who have a ſtone running upon its edge for bruiſing them, provided the ſhoots are not older than from three to four years, and that there are no impediments to interrupt the ſcythe: hence he draws an inference that, in many caſes, whins are the moſt profitable crop that a ſoil can bear, provided they be duly managed.

* See Headrick, in Communications to the Court of Agriculture, vol. II. p. 262.

removed, by paring off a very thin ſlice of the ſurface ground with it, and then either conſumed by means of fire, or applied to ſuch other purpoſes as may be neceſſary *. In the dry ſpring months it is indeed capable, in many caſes, where it grows high and of conſiderable cloſeneſs, of being burned without the labour and expence of either of theſe operations. But in all caſes where fire is employed, as the ſtaple of ſoils of this kind is ſeldom deep, care ſhould be taken that the combuſtion be not carried to too great a height, ſo as to prove injurious by conſuming the ſmall portion of vegetable material that may be preſent †. The operation of cutting the heath may be moſt conveniently performed by an implement of the ſcythe kind, only made much ſhorter and of greater ſtrength, ſo as not to give way or break by the ſtiffneſs of the ſtems of the plants.

The heath having been removed in ſome of theſe ways, lime in its cauſtic or moſt active ſtate is to be applied in large proportions, either over the whole of the ſurface before the ground is ploughed, or upon the ſoil when turned up. The former method is, however, to be preferred, as coming more intimately in contact with the plants, where lime is ſcarce, and cannot be laid on in large quantities; but where it is plentiful, the employing it in both ways might be more beneficial, by its thus tending more readily to the deſtruction of the roots as well as the ſtems of the plants. Where it can be procured, lime ſhould, however, always be put on in large proportions on firſt bringing heathy or moory ſoils into the ſtate of cultivation, as little ſavings in this reſpect in the firſt inſtance may often prove highly diſadvantageous in the end. It has been obſerved by an able writer, that experience has proved that the addition of lime to the aſhes of the pared ſurface operates greatly more beneficially than if ſpread in any other manner: and that the larger the quantity the greater the effect, and probably the greater the proportional effect; that is, ſix chaldrons an acre will do more than twice the good of three chaldrons; the chemical effect both in neutraliſing the acids found in all theſe ſoils, and alſo in deſtroying the roots left of the ſpontaneous growth, depending in ſome meaſure on the effect taking place ſuddenly. It has been known, that eight chaldrons an acre, laid on at

* It is well remarked by Mr. Headrick, in the paper mentioned above, that long heath makes a moſt excellent thatch for houſes, far more durable than ſtraw of any kind; it alſo makes excellent rinces for ſcrubbing milk veſſels. From its extreme durability, it is alſo the beſt of all ſhrubs for making concealed drains.

† See ſection on Paring and Burning.

once, have converted a moor into meadow worth twenty-five ſhillings an acre; but the ſame moor, under one chaldron per acre per annum for eight years, has not been worth ſeven ſhillings and ſix pence an acre. The effect of lime on all ſoils long in cultivation, is, he thinks, problematical, and does not anſwer the expence in one caſe in ten; but in new moor lands the effect is prodigious and hardly credible: laid on ling mountains without tillage, without paring, or other operation than merely cutting the ling and ſpreading the lime, ſuch moors have been changed from one ſhilling to twenty ſhillings per acre; but the quantity has been fifteen or twenty chaldrons per acre*. The application muſt, however, always be regulated by the circumſtances of the caſe. Where the expence per acre is forty or fifty ſhillings, the improvement will ultimately come high. And in order that the calcareous matter may be as intimately as poſſible blended with the particles of the ſoil, and thereby exert its effects moſt extenſively, it ſhould be applied over the land in the moſt perfect ſtate of pulveriſation, and as equally as it is poſſible to ſpread it out. Where the lime is applied with ſufficient attention to theſe circumſtances, it generally deſtroys the heath in a ſhort time, probably in ſome meaſure by its powers of attracting moiſture from the ſoils, and combining with the acid aſtringent juices of the plant, and rendering them incapable of affording it that kind of ſupport which is requiſite for its healthy growth, as well as by the alteration of texture that is produced in the land, and the cauſtic deſtructive action that may take place in conſequence of its coming into contact with the roots in that ſtate. This is probable from its being found to be the moſt effectual when laid on ſuch lands in the ſtate of quick lime, though ſomething may no doubt depend on the eagerneſs with which moiſture is attracted by it in ſuch caſes. After the lime has been applied, eſpecially where the ſurface has been pared off and conſumed by fire, the ploughing ſhould only be ſlight, ſo as to blend it and the aſhes with the ſoil, but not to place them at a great depth below the ſurface.

Where heathy or moory land has a higher degree of ſurface wetneſs, and is not ſo much overrun with the plant as to prevent its being employed as paſture, it may ſometimes be brought into cultivation by merely removing the ſuperabundant moiſture by proper drains, burning the heath in the ſpring months when ſuitably dry, and afterwards paſturing it cloſely with ſheep ſo as to keep it from ſeeding; as in this way, in time, it in ſome caſes becomes wholly removed†.

* See Young's Annals of Agriculture, vol. XX. p. 369.

† See ſection on the Cultivation of Graſs Land.

When this fort of ground has been broken down and pulverifed as much as poffible by the operations of ploughing and harrowing, it fhould always, where not too ftiff, be fown with fome fort of clofe, luxuriant, green crop, fuch as turnips, peas, and tares, that may be fed off by fheep ; but where it has a four quality, and is more ftiff, clayey, and adhefive, thofe plants that ftrike more deeply into the foil, as beans, Swedifh turnips, buck-wheat, rye, and oats of the grey kind. In many cafes too, rape, peas, clover, and vetches, will fucceed in a very beneficial manner. But as the principal intention in moft cafes of breaking up this fort of land, is that of bringing it in a cheap and expeditious manner to a fuitable condition after a grain crop or two for growing grafs, the green crops, of whatever defcription they may be, fhould be confumed by animals upon the ground, efpecially where the foil is fuch as to admit them without injury ; as in this method a high degree of fertilifation and improvement may fpeedily be obtained at little or no expence, from the great benefit the animals receive. If it can be conveniently done, two or more of this fort of crops may be confumed on the land in the fame feafon * with ftill more beneficial confequences. Where the foil is too wet, ftiff, and poachy, to admit of this practice, the crops may be drawn, or cut, and converted to the feeding of cattle in the houfe. It has been well obferved, that proper cropping "is the key-ftone of the arch ;" and that if it be not attended to with great care, the whole of the improvement may turn out difadvantageous †. There is, however, another method of improving thefe foils by fuch crops, which is that of turning them down, when in their moft fucculent ftates, by the plough. This may be a judicious and ufeful mode on the drier and more fandy defcriptions of thefe foils, where they may readily undergo putrefaction and decay ; but in the more tenacious forts, and where there is a four difpofition that would greatly retard the procefs, it would feem to be much lefs beneficial than that of feeding them off by fome fort of live ftock.

But in whatever method they may be brought into the ftate of cultivation, the proceffes of tillage fhould not be carried further than the deftruction of the heathy or other coarfe plants, and the removal of the four and unfriendly difpofition of fuch foils for the growth of ufeful vegetable productions. They fhould be then reftored as foon as poffible to the ftate of grafs or pafture.

There is another defcription of land, which approaches in fome degree to

* See Headrick, in Communications to the Board of Agriculture, vol. II. p. 265.

† See Young's Annals of Agriculture, vol. XX. p. 371.

the nature of the above, that in bringing into tillage requires the coarſe plants and herbage that it is naturally diſpoſed to produce, to be extirpated and removed, as well as the hills and other inequalities that are ſometimes preſent levelled down and deſtroyed, before the plough can be properly employed upon it. This is that which, from its moiſture, is naturally ſubject to the growth of ruſhes and other coarſe aquatic plants, and that on which ant, mole, or other ſorts of hills have been from long inattention and neglect ſuffered to accumulate to a large ſize, to become numerous, and to be covered with a tough ſward. In caſes of breaking up this kind of coarſe graſs land for the purpoſe of tillage, much may be effected where they are very wet, by firſt forming ſuch concealed or other kinds of drains as may be neceſſary according to circumſtances for carrying away as much of their moiſture as poſſible ; as by this means the tendency to throw up crops of theſe coarſe plants may be greatly leſſened, while at the ſame time the land is rendered more proper for the growth of moſt ſorts of grain, or even green root-crops. After this has been as much as poſſible accompliſhed, paring and burning may frequently be moſt beneficially employed, as by theſe operations the whole of the coarſe vegetable products are at once completely reduced and deſtroyed, while a ſlight portion of manure is added in the aſhes, and the ground is made ready for being ploughed, and the ſeed being introduced, in the ſhorteſt ſpace of time poſſible ; whereas, when the ſward is turned down after the coarſe plants only have been removed, a conſiderable length of time is required before it becomes ſufficiently rotted down and reduced by putrefaction, for the bearing of good and uſeful grain or root-crops. There are other views in which this practice may be uſeful ; as by the more effectual pulveriſation and aëration of the ſoil that is produced, which is of great utility in ſuch land, as well as by the more complete deſtruction of thoſe inſects that are ſo numerous and often ſo injurious to crops ſown on theſe grounds *. But, inſtead of the practice of paring and burning, it has been ſuggeſted by a late writer as more advantageous, after the turf is cut from the ſurface of coarſe land, which is meant to be reclaimed, to collect it all into heaps in different parts of the field, and make it up into compoſt with lime. The turfs he recommends to be completely drenched with water at the time the lime is applied ; and then frequently turned and champed among it, receiving as much water as they can retain at ſuch periods. By theſe means they will, he ſuppoſes, ſoon be reduced into a manure of the moſt excellent quality ; all the

* See ſection on Paring and Burning.

fibrous parts of the plants will be rotted, and converted into fubfiftence for the fupport of new vegetable productions. At the conclufion of the procefs, as the lime muft then have loft moft of its caufticity, as much dung, or other putrefcent manure, as can be fpared, may be mixed with the compoft. The compoft, having been thus formed, fhould be replaced over the whole furface of the land as equally as poffible *.

By reducing the vegetable materials of the foils in this way, it is fuppofed that there is not any lofs fuftained, as is the cafe where fire is employed. But it is evident, that even where the procefs of decompofition is effected in the moft eafy manner, as by fuffering fubftances to run naturally into putrefaction, there is always a confiderable efcape of ufeful elaftic matters; it can hardly be doubted but that much lofs muft take place where it is accomplifhed with a degree of violence, as muft be the cafe where lime in its cauftic ftate is combined with green fucculent vegetable fubftances. Befides, in this mode of practice, the expence of bringing the materials together fo as to be difpofed of in this manner, will often be too great to repay the cultivator; and in fome fituations lime cannot be at all procured. As it is, however, as has been already feen, a convenient and expeditious method of bringing coarfe, ligneous materials of the vegetable kind into an earthy condition, it may in different inftances be had recourfe to with beneficial effects. The feparation of ant-hills where they are abundant, and blending them with lime in this way, might alfo be an ufeful practice, efpecially as they often contain much animal matter at certain feafons, and are fo bulky as not to be difpofed of without being removed from their fituations. In all fuch cafes, the quantity of lime fhould only be fuch as to exert a gentle operation on the vegetable materials with which it is thus combined; as where a large proportion is employed there may not only be a great lofs by its too quickly difengaging the elaftic matters from them, but by its reducing fome of their more fibrous parts into an indiffoluble coaly ftate.

There is, however, another method in which land of this kind may be readily brought into the ftate of cultivation, where the coarfe vegetable matters are not ftrong or very thick on the ground, as is the cafe in fome coarfe paftures. This is that of having a fharp *flay* or *wing* attached to the plough, fo as to cut up and depofit a thin paring of the furface or fward in the bottom of the furrow, which is effectually covered by the furrow-flice that is immediately raifed by it from below †. In this way the land becomes at firft, after being well harrowed,

* See Communications to the Board of Agriculture, vol. II. p. 206.

† See fection on Implements.

nearly as fine as by a fallow; and the crop is in lefs danger of being injured by the growth of weeds. A ftrong team will, however, moftly be neceffary in performing this bufinefs, which in fome inftances, where the land is foft and full of moifture, may do harm by the treading that takes place.

In damp, ftiff, clayey, or what are frequently denominated *tilly* foils, there is often great labour required in bringing them into the ftate of tillage. As in thefe cafes too much moifture is generally retained at a little depth below the furface, the foil can feldom be rendered dry to a fufficient depth for the growth of good crops. Proper draining fhould be here firft attempted; after which the land may be opened up as deep as poffible by the common plough, having others, fuch as that which has been termed a *miner*, following in the bottom of the furrow, fo as to open and loofen the foil in a very deep manner, and in that way remove the water to fuch a depth below as to prevent it from doing much injury to the crop.

It has been well obferved, that where the earth has only been opened to the depth of a few inches above a ftiff clay, or other kind of retentive under foil, whenever rain comes in large quantities the greateft part of it muft be foon carried away, or the land will be drowned and rendered unfit for the growth of crops, whatever may be its condition in other refpects. Hence the neceffity of the practice of making a fufficient number of open-furrow drains on fuch foils, for readily and effectually conveying away the fuperabundant moifture or wetnefs. This water, it is faid, flows partly along the furface until it falls into the furrows, and it partly finks through the mold till it reaches the open furrow; but, unlefs it be during very heavy dafhes of rain, the greateft part of the moifture finks gradually through the pervious mold, until it meets with the impervious fubftratum that lies below it. When the water reaches that fubftratum, it forms a kind of fubterranean lake, which finds no iffue, until by its gravity it forces for itfelf a paffage laterally through the crannies of the mold, till it at laft reaches the open furrows prepared for that purpofe, which afford it then a ready outlet, through which it can flow off the ground. In thefe circumftances it is obvious, that the portion of the mold which lies immediately contiguous to the fubftratum, muft be, for fome inches in depth, more or lefs in proportion to the quantity of rain, and the tenacity of the foil, in a ftate of bog or watery quag, that is unfit for fuftaining any of thofe plants which it is the aim of the hufbandman to cultivate in this climate. In this ftate, too, the mold there being fo long foaked in water, and fo frequently drenched by it, muft have every material it contains that is foluble in water completely wafhed out of it in a very fhort time, and its

particles ſo frequently and thoroughly ſoaked as to reduce it to a kind of paſte, fitter to be converted into a brick on drying than to become a friable mold. If the earth be looſened by the plough only for a few inches depth on the ſurface of ſuch ſoils, the whole of this paſting proceſs muſt take place among the only mold in which the plants that grow upon it can ſeek their nouriſhment; ſo that this ſoil muſt be at one time in the ſtate of a pap that would be too thin for the mortar in a maſon's tub, and at another time it muſt be as dry, and nearly as hard, as a ſun-made brick. In this condition what ſort of crops, it is aſked, can be expected of any kind? It is this ſort of management which, for the moſt part, is the cauſe of that kind of ſtarved unproductiveneſs of ſoil, which is known among farmers by the name of *hide-bound*, which many men believe it would be throwing away money to attempt to reclaim. And it is certainly true, that ſo long as men ſhall continue the practice of ſuch ſcratching of ploughing as that here taken notice of, they judge rightly. But under the ſyſtem of management above deſcribed, many of theſe ſoils may in time be rendered amongſt the moſt productive in the iſland, and with great profit too to the judicious operator. When the ſoil is opened up by the proceſſes recommended above, it is rendered pervious to water to the whole of the depth to which it is looſened; while at the ſame time the water is allowed to find its way off the ground at a depth ſo far below the ſurface, as not to injure that portion of the mold in which the principal roots of the plants abound. Indeed, a great part of that moiſture, in theſe circumſtances, never finds its way off the ground at all; but ſoaking gradually downwards, that water, which, if it had only been allowed to ſink three inches, muſt ſoon have reached the bottom, and there have been regorged back upon the ſoil, will require at leaſt five times as long a period to ſink to fifteen inches deep, and in its progreſs will be only gradually moiſtening, inſtead of drenching the ſoil; ſo that if the rain ſhall ſubſide before it has reached the bottom, no part of that water will be carried off the field, unleſs what flows over the ſurface; but it will there remain to moiſten the earth only to a ſalutary degree, and, like the water in the ſtomach of a camel, afford a ſupply when drought comes on, and parches the ſurface of the ground: for the deep fibres of the roots penetrating downwards, there will find moiſture, which thoſe near the ſurface would then be deprived of. Thus does the practice recommended operate alike as a cure for the exceſs of wet as of drought, and produces a healthy vegetation in all circumſtances. One would wonder, that ſeeing the effects of this proceſs ſo univerſally in our gardens, to which theſe owe in a great meaſure their ſuperior degree of fertility, men ſhould

ſo ſeldom have adverted to the benefits they would derive from the ſame proceſs being extended to the fields. They ſee, it is further remarked, that in gardens, even where the ſoil is very retentive, good crops are produced without water furrows at all; whereas in fields of the ſame nature they know that nothing of this ſort could be expected *. It has, indeed, been alſo aſſerted, that the above implement has been ſucceſsfully employed to cut out ruts in the bottoms of the furrows, when the land is croſs-ploughed, and alſo to deepen the water-furrows ſo as more effectually to diſcharge the water. Theſe ruts divide the ridges into ſmall chequers, and although they are covered again with the ſoil, they ſtill retain ſuch a degree of openneſs, as to permit water ſlowly to percolate. A rope of ſtraw or hay placed here and there into theſe ruts, converts them into permanent concealed drains †.

It has likewiſe been propoſed in theſe caſes, after the ruſhes or other coarſe vegetables have been cut down and carried away, to throw up two furrow ſlices that have been cut deep by a ſtrong plough againſt each other, ſo as to form a conſiderable elevation in the middle of the ridge, and then with a paring-plough or ſpade to follow the plough, and ſtrip off a ſod of about an inch in thickneſs, and the breadth of a furrow ſlice, which being thrown into the bottom of the furrow previouſly made, with the heathy or ruſhy ſide undermoſt, is to be trod down by a man who follows the ſpade or paring-plough. And that laſtly, the ſtrong plough is to follow the paring-plough, and heave up the earth which it had laid bare to the depth of about a foot, throwing it over upon the ſod previouſly placed in the oppoſite furrow. By this means, it is ſuppoſed, that the ſods compoſed of ſhort heath, ruſhes, or other coarſe herbage, being buried at ſuch a depth below the ſurface, muſt ever after keep the ſoil open, allow the water to percolate, and a great depth of ſoil be at the ſame time obtained. Or, what is conceived might be a ſtill more beneficial method in theſe ſoils, is that of ſcooping or hollowing out ſmall ruts or openings at ſhort regular diſtances, in the bottoms of ſome of the furrows, with the *miner*, or ſome other convenient implement of a ſimilar kind, and then filling them with the heath, ruſhes, or other coarſe materials that may have been cut from the ground, covering the whole with the paring of ſward as before. It is imagined that in this way each would perform the office of a concealed drain, and convey away the exceſſive moiſture at the

* See Anderſon's Eſſays, vol. III. p. 237.

† See Communications to the Board of Agriculture, p. 267.

bottom of the ridge, the ſward or upper covering preventing them from being ſtopped or filled up by the mold. By ſuch means, the moſt obdurate and irreclaimable clay, being kept open below and free from moiſture, may, it is ſaid, ſoon acquire all the properties of a ſoil of the greateſt depth and fertility.* The buſineſs in theſe caſes, though capable of being done by proper implements of the plough kind, is always performed with greater exactneſs by means of the ſpade. But in either way it can probably be advantageouſly had recourſe to only where the price of labour is cheap.

Experiments have ſhewn that waſte ſoils of the moſt obdurate kind, ſuch as conſiſt of thin, moory earth, upon aluminous and pyritical clays of conſiderable depth, fit only for bricks, may be rendered mellow and fertile, by cutting the hard adheſive ſurface ſlices after being ploughed up into pieces, forming them into a kind of walls or dykes in order to their being more fully acted upon by the influence of the atmoſphere; and after they have been thus conſiderably reduced, mixing them into compoſts with lime, and re-applying them, the bare under ſoil being in the mean time well ploughed or wrought with the ſpade, and incorporated with lime †.

In theſe ways the practice of paring and burning may in many caſes be rendered unneceſſary, where the ſward is not too tough and matted, or covered too thickly with coarſe vegetable productions; but wherever there is much toughneſs of the ſurface, or a great abundance of rough plants covering it, there can be little doubt but that the method of paring it off and conſuming it by fire, will be the moſt eaſy, effectual, and expeditious manner of bringing the land into a ſtate of cultivation.

As in the breaking up of waſte lands, whether they be thoſe of the ſtiff and heavy kinds, or ſuch as are of a more light and friable nature, repeated ploughings will frequently be required, not only with a view of reducing the ſward and other parts into a mellow and pulveriſed condition proper for the growth of crops, but to fill up the hollows and inequalities that are generally met with in ſuch lands, in order that they may be laid in a ſuitable manner for the purpoſes of tillage, it will be neceſſary to keep in mind not only the peculiarities of the ſoil and climate, but the kind of crop and the method in which it is to be put into the ground. Thus ſome of the ſtiffer ſorts of ſoil, in a climate where too much rain does not fall, may be much benefited by being expoſed to the influence of the atmoſphere during the winter ſeaſon; while others under

* See Communications to the Board of Agriculture, p. 267. † Ibid. p. 268.

contrary circumſtances may be injured, by being thus rendered more liable to become wet and miry, and on the approach of dry weather ſo hard and compact in their texture as to be improper for the reception and growth of crops; theſe ſhould therefore be ſubjected to the operations of tillage chiefly in the early ſpring months, when the injuries to be apprehended from wetneſs are daily becoming leſs. Where ſome ſorts of grain crops, as wheat and barley, and thoſe of the green kind, ſuch as turnips, potatoes, peas, and many others, are to be cultivated, the land ſhould always be rendered more fine and mellow by theſe means, than where other crops, as oats, &c. are to be grown. And, indeed, wherever the practice of the drill huſbandry is to be purſued in putting in and cultivating crops, it is moſtly advantageous to have the land as ſoon as poſſible brought into a ſtate of as perfect pulveriſation as can be effected; as from the frequent ſtirrings afterwards, under this ſyſtem of management, there is ſeldom any danger of its becoming too hard from being baked by the heat of the ſun.

In managing the buſineſs of levelling the land, as it can ſeldom be effectually performed by the plough, various implements have been conſtructed in order to expedite the work; but as they can rarely be managed with that eaſe and facility that is requiſite for the common labourer, it is probable that the ſpade and common wheelbarrow, or ſingle-horſe cart, when judiciouſly employed, are by much the beſt implements that can be had recourſe to for ſuch work; as by ſuch means the earth can be taken away or depoſited upon thoſe parts where it is moſt wanted, and to the improvement of which it is from its nature and qualities the moſt ſuited; a circumſtance that ought invariably to be attended to, as in this way the more open and porous materials will be laid in the ſtiff and adheſive parts, and ſuch as are more cloſe and compact, on thoſe that are looſe and friable. It is obſerved by Mr. Headrick, in his valuable paper on bringing waſte lands into cultivation, that he has ſeen many levelling machines for reducing inequalities and for ſcooping out ſlope drains, where neceſſary, in a field; but he never ſaw any that did not do infinite miſchief to the land on which they were uſed. They require, ſays he, immenſe force, of courſe every animal that drags them ſinks to the knees at every ſtep, and leaves holes in the ſoil in which water will lodge for ever. They leave no choice of the ſpot, where what is dragged out of one place, is to be depoſited. The neareſt hollow is the ſpot where, right or wrong, the contents of ſuch machines muſt be dropped. Where ſuch machines operate upon deep, loamy, and friable ſoils, they may do no miſchief, though all their effects may be attained in a much more cheap and economical manner;

but he has feen fome land wholly fpoiled and rendered unproductive by the ufe of fuch machines.

He alfo fuggefts, that by having the barrows to run upon ftrong coarfe pieces of deal in the way of rails, much advantage may be gained, efpecially for fhort diftances, in the economy of labour; and that fmall carts or other forts of carriages, placed upon low broad wheels or rollers, and drawn by one horfe, might likewife be ufeful in accomplifhing this fort of bufinefs. High carriages, whether carts or waggons, are conftantly to be avoided for fuch ufes, as caufing much unneceffary exertion, and a great wafte of ftrength in raifing the materials.

There is another defcription of land that is frequently to be brought into the ftate of tillage, in which the methods that are to be adopted are in fome refpects different: this is that of the boggy kind. In thefe, the firft thing after having them well drained by the cutting of proper ditches—which, where they are large, may ferve for their inclofure, and by giving the ridges a fuitable form in order to aid this—is to pare off and level the furface by means of the fpade or plough; fuch matters as are of little value being depofited in the hollows, while thofe that are of a good quality may be mixed into a compoft with good dung, where it can be procured, or with lime: or if the furface materials be very coarfe, it may be more advantageous to confume them by fire, together with the fpare earth taken from the ditches; or this earth may be afterwards blended with the afhes and a little lime: but, in whichever way, they fhould be immediately fpread equally over the land, and incorporated as much as poffible with it, by ploughing it up with a very flight or ebb furrow, in order that the uniting materials may not fink too deep for affording due fupport to the crop that may be cultivated. Indeed, though deep ploughing may fometimes be of utility in firft opening up thefe foft foils, it fhould never be had recourfe to when the application of manure is to be made, for the reafon that has been juft ftated; and on this account alfo the ploughings after the taking of different green crops fhould only be flight. Where the furface of land of this fort has not been pared and burned, in moft cafes more labour and expence will be neceffary in repeatedly ploughing, in order to bring the foil into a proper ftate for the production of crops. It is feldom proper to continue foils of this defcription for any great length of time in the ftate of tillage, as from their great moifture, on account of the general flatnefs of their fituation, and their being liable from continued ploughing to become very loofe and open, fo as not to afford proper

nouriſhment or ſtability to the roots of the crops, this ſort of land will, in general, be the moſt advantageous in the ſtate of graſs *.

The moſt beneficial ſorts of crops for theſe ſoils will, in general, be turnips, rape, or potatoes: where they have been pared and burned, the former may be ſown broadcaſt, and be eaten off by ſheep, when the land will be ready for ſome kind of grain crop with ſeeds. When the ground is very ſoft, the turnip or other ſeeds may be ſown immediately among the aſhes without ploughing, and be harrowed in with a ſmall harrow drawn by men, and afterwards rolled well down. In this way it ſoon becomes ſo ſolid as to admit the plough. Rape is more ſuitable for the firmer and more ſolid deſcriptions of land of this ſort, on account of its ſtrong roots, which have the tendency of opening and looſening the ſoil very conſiderably, as well as of rendering it highly mellow on the ſurface, by the thick ſhade of the leaves. The light and drier parts will be the moſt adapted to potatoes, as their bulbous roots will be there the moſt able to ſpread and extend themſelves, and conſequently produce large crops. Theſe crops will, in the ſtiffer ſorts of theſe ſoils, leave the land in a ſuitable condition for wheat or oats, and in the lighter for barley or rye. In ſuitable ſituations in reſpect to markets. theſe ſoils are well adapted for the growth of many ſorts of garden vegetables.

In moſſy ſoils of the more extenſive and deep kinds, which form a variety of this deſcription of land, different methods have been attempted in bringing them into the ſtate of tillage †. By ſome the whole of the moſſy material has been removed by the aid of water and ſuitable machinery, ſo contrived as to raiſe it above the level of the moſs. It has been ſtated by a late writer that the expence of a machine for this purpoſe, and the embankment neceſſary for it, in the caſe of an improvement of this ſort made by the ſon of Lord Kames, was £.1000 ‡, and it has been ſuppoſed to be even £.1500. It is obſerved, that when the water arrives at the higheſt part of the moſs, it is conveyed in a rut perpetually deſcending along the whole line of the uncleared moſs; at every part of this line the people are employed in throwing the moſs into the ſtream with ſpades. Thoſe at the part where the water firſt enters the moſs, keep the ſtream upon the ſurface, and they lift and throw into it all the moſs within their

* See ſection on the Cultivation of Graſs Land.

† The nature, formation, and analyſis of theſe ſoils have been ſo fully treated of by Dr. Anderſon, in his Eſſay on Peat Moſs; and Mr. Headrick, in his paper On the Modes of bringing Waſte Lands into a State fit for Cultivation; that we think it unneceſſary to deſcribe them.

‡ See Robertſon's Survey of Perthſhire.

reach, until they uncover the clay below; they then cut out a new water-course, and throw into it the embankment of mofs which fuftained the water before: thofe lower down operate in the fame way, only they preferve the current of water on a lower level than thofe above them; thofe at the loweft part keep the water running upon the clay, and fhift its courfe occafionally, fo as to have it running along the bank or face of uncleared mofs: thus, at every point along this water-courfe, people may be employed in heaving in pieces of mofs by the fpade, and they conftantly fhift the pofition of the ftream, in proportion as the mofs is cleared away * †.

The foil that prefents itfelf after the moffy matter is conveyed away in this manner, is a fort of clayey marle, with a confiderable mixture of marine fhells in different places. Its natural fertility is confiderable, but found to be much improved by being raifed into pretty high ridges, and expofed to the influence of the atmofphere during the winter feafon immediately after its being firft broken up. Lime, peat, afhes, and manures of the dung kind, are afterwards applied to it with beneficial effects in promoting its improvement. It has been fuggefted, that as lime, which is highly neceffary to fuch foils, cannot be eafily procured in many places, while fea fhells are in abundance, they might be eafily dug up and converted into lime by a moderate degree of heat. It is probable too, that by being broken or otherwife reduced into a fine powder without calcination, they might frequently be applied with confiderable improvement; though in the ftate of quick lime they would be more ufeful in fome cafes, by their more ready combination with the acid matters of fuch foils: this would feem to be moftly the cafe where the moffy matter had not been floated away, by which a heavy expence might be faved. Where mufcles or other forts of fhell-fifh are to be procured in fufficient quantities in the neighbourhood of the moffes, they might alfo be employed with benefit, when reduced by a mill, fimilar to thofe employed in grinding oak bark, and afterwards incorporated with a large proportion of good peat or other earth; as by this means calcareous matter, as well as a rich animal manure, would be at once applied. But, independent of the circumftance juft mentioned, the floating

* See Communication to the Board of Agriculture, p. 309.

† Mr. Headrick found on enquiry, that in this way it required the labour of a man nearly a whole year to clear one Scotch acre of mofs, and reduce it into a condition to receive a crop. This labour cannot be eftimated, he fays, at lefs than £.25; to this add the price of feed, compound intereft upon the original erection of the machine and embankment, &c. and the expence of this mode of cultivation will not, he thinks, appear trifling.

of moſſes can only be practiſed in inſtances ſimilar to the above, where the ſub-ſoil is rich and good, as in moſt ſituations it has been found that the bottom ſoil is either compoſed of rocky materials, whitiſh granite, or pyritical gravel, and pyritical and aluminous clay *, which muſt conſtitute a ſoil much worſe than the peat earth, and which could ſeldom be cultivated to advantage.

Another method of bringing this ſort of ſoil into cultivation, and which in many ſituations is much readier and leſs expenſive, as being accompliſhed without the floating of the moſs: this is by the application of lime in its cauſtic ſtate, in large quantities, after the land has been rendered as dry as poſſible by the cutting of large ditch drains. This is a method of practice that has been carried to a great extent, and conducted with much ſucceſs, in Ayrſhire, in Scotland †, and which has ſince extended itſelf over different diſtricts in the ſame neighbourhood. The benefits reſulting from the cultivation of this ſort of ſoil are ſuch as to render it an object of great attention. Such, indeed, are its advantages there, that "the culture of moſs has become, in many caſes, a diſtinct ſpecies of farming, to which individuals apply to the neglect of every other purſuit ‡."

* See Headrick, in Communications to the Board of Agriculture, vol. II. p. 311.

† It ſeems from Mr. Headrick's account, to have been accidentally introduced by John Smith, eſq. of Swinridge Muir, near Beith.

‡ It is obſerved by Mr. Headrick, that the following detail may aſſiſt the inexperienced to form ſome idea of the value put upon moſs by thoſe who are acquainted with it: A young man, ſon of a farmer on the eſtate of Swinridge Muir, has taken 20 acres of moſs from William Patrick, eſq. of Trehorn, writer to the ſignet in Edinburgh, for four crops, at 25s. per acre of yearly rent. All that was done by the proprietor was to dig the maſter drains, which alſo ſerve the purpoſe of fences; in other reſpects the moſs was delivered in its wild and unſubdued ſtate, the tenant being at all the expence of working and manures, and obliging himſelf to lime, at the rate of ten Ayrſhire chalders per acre. The moſs was in crop, 1797, for the firſt time. Mr. Headrick was ſeveral times upon it, and remarked, that where the lime had been early enough applied, which was the caſe with the greateſt part of it, the crop (oats) was uncommonly good; even the worſt was much better than ſome contiguous land which had been torn from Muir, and limed. On a ſmall corner, which had got no lime, nothing grew. The proprietor himſelf expected no ſuch rent, had it not been voluntarily offered by the tenant. The ſolid land there, which has been long in cultivation, does not average 20s. of rent, as the ſituation is not very acceſſible.

Two ſmall patches of cultivated moſs, contiguous to the town of Beith, were lately let at the rate, the one of £. 10 per acre per annum, for two crops of potatoes, the other for £. 7 per acre for two crops of oats, to be ſown down with graſs ſeeds. The firſt of theſe patches had been conſtantly in potatoes ever ſince it was reduced to cultivation, and the occupants were to furniſh what dung they choſe for their crops at their own expence. The ſecond patch, of more than three acres, had been conſtantly either in potatoes or oats from the time of its firſt ſubjugation, and would have given much more, had potatoes been permitted; but it was thought adviſable to bring it into graſs. It muſt be

The manner of proceeding in bringing this ſort of land into tillage is ſo well deſcribed by the author of the valuable paper we have juſt quoted, that we ſhall inſert it in his own words. "In entering upon the improvement of a moſs in its natural ſtate, the firſt thing to be done is to mark out and cut main or maſter drains, eight feet in width by four and a half in depth, and declining to two and a half at bottom; theſe coſt one ſhilling per fall of ſix Scotch ells. In ſome inſtances it will be found neceſſary to cut theſe drains much deeper, conſequently at a greater expence. Theſe drains almoſt in every inſtance can, and are ſo conducted as to divide the field into regular and proper incloſures. They always make it a rule to finiſh off as much of a drain as they have broken up before they leave it at night, becauſe if a part is left dug, ſuppoſe half way, the oozing of water from the ſides would render the bottom ſo ſoft that they could neither ſtand upon it nor lift it with the ſpade. When the moſs is ſo very ſoft that the preſſure of what is thrown out of the drain may cauſe its ſides to fall in again, they throw the clods from the drain a conſiderable way back, and ſometimes have a man to throw them ſtill further back, by a ſpade or the hand; for this reaſon too, they always throw the ſtuff taken from the drain as equally as poſſible on each ſide of it. In digging the drains, the workmen ſtand upon ſmall boards, to prevent them from ſinking, and move them forward as the work advances. When the moſs lies in a hollow with only one outlet, it is neceſſary to lead up a drain, ſo as to let the water paſs this outlet, and then conduct it along the loweſt or wetteſt part of the moſs; this middle drain is afterwards ſloped, and the ſtuff thrown back into the hollows that may occur; upon it, the ridges are made to terminate on each ſide, while a ring-drain, ſervin the purpoſe of a fence, is thrown round the moſs at the line where the riſing ground commences. This can generally be ſo managed as to divide the moſs into a ſquare field, leaving ſtraight lines for the ſides of the contiguous fields. The ring-drain intercepts the ſurface water from the higher grounds, and conducts it into the lower part of the outlet, while the ſloped drain in the centre receives and diſcharges all the water that falls upon the moſs. After the moſs collapſes, in conſequence of liming and culture, it is often neceſſary to clean out theſe drains a ſecond time, and to dig them to a greater depth: their ſides become at laſt like a wall of peat, which few animals will venture to paſs."

admitted, that land immediately contiguous to a town fetches a rent for conveniency, as well as for what it actually produces; at the ſame time it muſt be obſerved, that the beſt ſolid land to which theſe patches of moſs belonged, and ſome of which had been long in paſture, brought only a rent of from £. 3 to £. 6 for two years' crop, the whole being let in parcels by public auction.

In cutting these drains in the mosses in Lancashire, one precaution has been found of the utmost importance; which is, that if the drain be cut to its intended depth at one operation, it will be impossible to prevent the sides from falling in, and no labour can afterwards effectually repair the damage. It is highly necessary, therefore, to attend to the nature and consistence of the moss, and not to cut deeper at one time than will suffer the sides to remain perfectly firm *.

When this business has been performed, the ridges, according to the first writer, are marked out, either by a line, or three poles set up in a line of the proper breadth, and formed in a way that will be mentioned when we come to speak of ridges. These are then to be top-dressed with lime. The sooner, says he, this is done after the ridges are formed the better. When the moss appears dry, experienced farmers throw on the lime, but do not clean out the division furrows until the ensuing winter. When it is soaked in water, and the the lime is ready, they clean the division furrows, and after the water has run off, apply the lime immediately. It is of great importance to have the lime applied while the moss is still moist, and the lime in as caustic a state as possible. For this purpose they have the lime conveyed from the kiln in parcels, slaked, and laid on as fast as the ridges are formed. Being dropped from carts, and slaked at the nearest accessible station, it is carried to the moss by two men on light hand barrows, having a hopper and bottom of thin boards, and there spread by shovels as equally as possible. During the first and second years, the crop is generally carried off in the same way. In some places, where a moss is covered with coarse herbage, and accessible by carts in dry weather, he saw them give a good dose of lime to the moss before it was turned up with the spade, and another after the ridges were formed. It is surprising, he says, how quickly they execute these operations with the hand-barrows. In other places where coarse boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

"The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much less sparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppose 120 bolls, or 480 Winchester bushels, of slaked or powdered lime allowed to every Scotch acre; this would cost at the sale kilns forty shillings; and thus the reader may be enabled to calculate the expence of lime per acre in this district, at every given proportion: but most of the farmers here burn lime for themselves in vast kilns of sod, and think they have it much cheaper than it could be

* Agricultural Report of Lancashire, p. 95.

got from a ſale kiln. In many places lime-ſtone abounds ſo much, that houſes, fences, roads, &c. are conſtructed with it; and when a farmer burns the lime-ſtone within his premiſes, he at leaſt ſaves the expence of carriage. In ſome caſes, after the lime is laid on, they go over the ground with hoes or with ſpades, hacking and mangling the clods, and mixing the lime more completely with the ſuperficial ſoil; but where there is much to do, and hands are ſcarce, they ſeldom think of theſe operations.

After the land has undergone this preparation, it is in a ſuitable condition for the reception of the ſeed, which it is obſerved is ſown at the uſual ſeaſon, whether it be *wet* or *dry*, and, as has been already ſeen, harrowed in by a ſmall harrow, drawn by two men *. It is ſtated that four men will with eaſe harrow at leaſt five or ſix roods per day, two and two dragging the harrow by turns, and two breaking and dividing the mold with ſpades. Where the liming has been accompliſhed at an early period in the preceding ſummer, a good crop may moſtly be expected; but if it has been only recently performed, the firſt crop frequently fails, from the lime not having had time to combine ſufficiently with the moſs ſo as to form it into a ſoil †. It is probable that this does not, however, wholly depend on the lime not having reduced the peaty earth to the proper ſtate of ſoil, but partly on its not having neutraliſed and deſtroyed the acid properties of ſuch ſoils.

In reſpect to the crops moſt proper to be cultivated on ſoils of this kind, ſome variety may be admitted, according as they are more or leſs wet, and have greater or leſs depth. But, as a chief point to be aimed at in cropping them at firſt, ſhould always be that of preventing their ſurfaces from being too much acted upon by the ſun and wind, ſuch plants ſhould be provided as have a tendency, by the luxuriancy of their growth, and the cloſeneſs of their foilage, to afford as much ſhade and covering as poſſible, as by the moiſture being thus preſerved the operation of the lime is much promoted. In this view, potatoes, turnips, winter rye, and rape crops, may, in the ſlighter boggy ſoils, be had recourſe to with ſucceſs. The firſt is a ſort of plant that has been found to anſwer ſo well, and been ſo highly productive on all moſſy ſoils, that it is the general practice, where manure can be procured, to cultivate them for the firſt crop; the cuſtom, in moſt inſtances, being to ſet them on beds or ridges a little raiſed. Where potatoes are grown more than one year on the ſame land, the ſecond crop may frequently be put in without dung. Turnips and rape may, however, in many caſes, be grown with great advantage, as firſt crops, on ſoils of this deſcription, both

* See Communications to the Board of Agriculture, vol. II. p. 318. † Ibid.

on account of their great value, the ſhade they produce, and their being capable of being put into the ground without ſo much digging as is neceſſary for potatoes.

Moſs-lands *, from their being much diſpoſed to the throwing up of graſs, are not ſo proper for the growing of grain crops, but a crop or two may frequently be taken after potatoes or turnips, eſpecially where the liming has been performed ſome length of time. Oats and barley are moſtly good crops, but ſuch land is often too light for wheat. The early white Poliſh oat is generally recommended in ſuch caſes, as being the leaſt liable to lodge, or run too much to ſtraw. Where barley is employed, graſs ſeeds are frequently ſown with it, but it is probably a better practice to put them in ſeparately. On thoſe ſoils, rye-graſs, as well as white and yellow clover, have been found to thrive extremely well, eſpecially where they were in a proper ſtate of preparation for them, as by the growth of potatoe or turnip crops. And though red-clover has not always ſucceeded, it is probable, that in ſuch moſſes as are not of the deep kind, it will be found an uſeful plant. In ſome diſtricts it has been found, that clover may be ſown with great advantage immediately after the potatoe crop, when it has been taken off early †.

And as it is neceſſary that there ſhould be a tolerable proportion of moiſture conſtantly preſerved in theſe ſoils, in order to promote the full operation of lime upon them, it would ſeem to be the moſt advantageous method in bringing

* It is obſerved, by Mr. Headrick, in the ſecond volume of Communications to the Board of Agriculture, that in Scotland the expence of delving a moſs for the firſt time, where the ſurface is tolerably ſmooth, is 2½*d.* per fall, or £.1. 13*s.* 4*d.* per Scotch acre; but where inequalities occur, which muſt be thrown by the ſpade into hollows, it coſts about £.2. per acre. If there be eminences, which muſt be removed into hollows, by wheelbarrows, running upon boards, the firſt expence is greater, according to circumſtances. The ſecond delving, where potatoes have not intervened, coſts from £.1. to £.1. 6*s.* per Scotch acre, the diviſion furrows being at the ſame time cleaned out. The third delving, and cleaning of the diviſion furrows, coſt £. 1. per acre; but the moſs is then ſo friable, that it may be wrought with the greateſt eaſe and rapidity. At the above rates, an ordinary workman will earn 1*s.* 6*d.* per day; and an able and experienced one, from that to 2*s.* 6*d.* per day. They uſe a ſtrong ſpade edged with ſteel, and have alſo a gritſtone near them, for ſharpening the ſpade. In the evenings they repair its edge upon a grindſtone, and when the ſteel is worn away, they lay it again with new ſteel. Sometimes the moſs is ſo ſoft, that they walk upon boards while they are turning it over.

And that when moſs is wrought by the ſpade, it ſeems to be of no conſequence whether it be wrought wet or dry; but when it is wrought by the plough, opportunities muſt be watched, as horſes cannot walk upon it, for ſome years, during wet weather.

† See Agricultural Report of Lancaſhire, p. 99.

them into cultivation, not to allow them to be rendered too dry by the cutting of drains, but to proceed with the bufinefs in fo gradual a manner, as that they may conftantly retain that degree of moifture which is moft fuitable for the complete action of the lime, without being too wet for the crops that are to be put upon them.

It is evident, from what has been advanced, that there is much variety in foils of this kind, and that they will of courfe require different modes of tillage. Where they are very thin, and depofited upon a loamy or clayey fubftratum, it may be a good practice, after paring and burning the coarfe top fward, to plough fo as to bring up a portion of them, by which, and the ufe of lime, the land may be rendered highly productive. And indeed, where they are of much greater thicknefs, this method has been advifed after their being fufficiently reduced by frequent turning up, drying, and burning; but it is probably a better method to depend upon the application of lime, where it can be procured in quantity fufficient for the purpofe. After paring and burning, on lands of this fort, the crops, efpecially thofe of the turnip, rape, or grafs kinds, may frequently be put in by means of a light harrow, without ploughing or digging them over.

Ridges.—In the conftructing of ridges on fuch lands as are to be brought into cultivation, great attention is not only neceffary to the nature and quality of the foil, but alfo to its fituation, as by thefe, their fize, height, and direction, muft in a great meafure be regulated. Where the land is of fuch a nature as to be highly retentive of moifture, or, from the peculiarity of its pofition, liable to become too wet for the growth of ufeful crops, the ridges fhould in general be made narrower, and have a more rounded or convex form, than in the contrary cafe, or where it is expofed to injury from becoming too dry. But in the firft cafe they ought not, however, to be raifed fo very high as is fometimes the practice, as by fuch means much inconvenience is often fuftained from the crowns becoming too dry, and the grain ripening in a flow and partial manner. Befides, narrow ridges, with but a little elevation, are, in general, much more effectual, in taking away the water that may be injurious.

Where neither the circumftances of the foil, nor the nature of its fituation, require that the ridges fhould be formed in a particular manner, or of any certain breadth, that of making them about eighteen feet may be the moft fuitable, as they are found to anfwer well in the way of keeping the ground properly dry, and of the moft convenient dimenfions for turning the teams in

ploughing. Befides, the feed, where this method is purfued, can be eafily fown by one caft up and another down ; an operation which, in other circumftances, would be attended with confiderably more labour. The covering of the feed by means of harrowing is alfo accomplifhed with more facility and difpatch, as by employing double implements of this kind, one turn may wholly finifh the bufinefs. In the reaping, too, they have advantages, in allowing the number of reapers that are neceffary to work with convenience, and without being in the way of each other.

In wet, clayey, or any ftiff and tenacious loamy foils, where the under ftratum is clay, they fhould, however, be ploughed as much as poffible into ridges of much lefs fize, in order that they may be kept in a ftate of drynefs, fuitable to the growth of the crops that are to be put upon them. Three or four feet, according to the degree of tenacity and wetnefs, may, in fuch forts of land, be fully fufficient. In the counties of Effex and Hertford, on this fort of wet foils, three feet are found to anfwer the purpofe in a very effectual manner; and it has been obferved, on the authority of much experience, that their fuperiority over ridges of greater breadths, for taking the water off without wafhing the land, is incontrovertible*. In fhort, as there is much variation in lands of thefe kinds, it may be obferved, that the width and flatnefs of the ridges fhould be increafed as they recede from the nature of clay or clayey loam, and approach that of fand, in order that a larger proportion of moifture may be preferved; while, on the contrary, as they are becoming more of a clayey quality, they ought to be narrower, and to have a more high and rounded form, that the difcharge of injurious moifture may be more expeditious. In loamy foils they fhould be either broad and flat, or narrow and round, in fome meafure, according to the degree in which they approach the fandy or clayey foils. In very wet, clayey foils, where they reft upon a fubfoil of fome porous kind, great advantage in the way of drainage may often be obtained by finking the furrows fo deep as to reach it.

In lands of the marfhy or fenny kinds, as moftly approaching in fome degree to the nature of thefe, the ridges fhould alfo be made narrow and rather round.

As the principal defect of land of the fandy kinds is that of parting with its moifture too readily, and of courfe becoming quickly in a ftate of too much drynefs for the purpofe of healthy vegetation, it is the moft advifable to plough them into very broad ridges, or even in fome cafes quite flat, with-

† See Agricultural Survey of Middlefex, p. 144.

out the leaft degree of furrow being made, as in this way the moifture may be more effectually retained in fuch foils.

In forming ridges on fuch foils as are of the boggy or moffy kinds, fome attention is neceffary in refpect to their depth, and the proportion of wetnefs that may be prefent; as where they are thin, and have but little injurious moifture, they may be more broad and flat, than where they are deep of mofs, and more retentive of moifture: fix or feven yards may, in general, be the beft. But, even in the deeper forts, long experience has fhewn, that in the firft inftance it is improper to make them too high or too narrow; where they are made too high, they throw the water off from their fides, without admitting it to penetrate their fubftance, the top of courfe gets too dry; when too narrow, there is a lofs of furface from too many divifion furrows: the breadths already mentioned are found to be the beft: and when the improvement is completed, the ridges appear like fegments of wide circles, with a clean well-defined divifion furrow between each of them. The moifture is thus caufed flowly to filtrate through the mofs, rendered friable by lime, until it reaches the divifion furrows, and is difcharged. As the mofs fubfides for fome time, and clofes in towards the furrows, it is generally neceffary to clean thefe out before winter, and at the time the crop is fown, until the mofs acquires folidity *.

The ridges in thefe foils are moftly formed by the fpade, the workman beginning nearly in the middle of the part which is to form the ridge, only leaving the fpace of about eighteen or twenty inches, upon which the materials raifed from the trenches on each fide are depofited, fo as to conftitute the crown; and in this way of digging up and turning over narrow fpits on each fide he proceeds till he comes to the divifion furrows, which are cut out and laid on the fides. The ridge being thus completed, and appearing as if done by the plough.

In deep moffy foils, efpecially thofe of the more fpongy kind, it is probable the breadth of the ridges may be increafed with advantage after they have collapfed and become fufficiently firm, as by fuch means they will be more fuitable for being laid down to grafs.

In regard to the direction of the ridges in lands of all defcriptions, where there is not a neceffity of giving them a particular pofition, either with a view to drainage, or fome other circumftance of importance, it fhould conftantly be, as much as the fituation of the grounds will admit, in the line of north and fouth; as in this direction much advantage may be obtained in the ripening and dry-

* Communications to the Board of Agriculture, vol. II.

ing of the crops, from their being more fully expofed to the influence of the fun and wind. It has, indeed, been remarked, that the fhocks, after grain has been reaped, fhould be fet in the fame direction, and not have an eaft and weft pofition, as in this cafe the fheaves on the north fide are many days later in being in a proper condition for being conveyed to the ftack, than thofe of the fouth. Further experience has alfo afforded the means of fhewing the bad effects of ridges having an eaft and weft direction; it being found that corn on the fouth fides, of fuch as were not by any means high, fhot into ear, and changed and ripened a week at leaft earlier than that on the north; and that at the time of reaping, the wheat on the fouth fides was, in fome patches, too ripe; while that on the north fides was in many parts abfolutely green*.

In forming ridges in fuch lands as are hilly, or have much declivity, it is neceffary that they be neither made too fteep, nor have too much of a horizontal direction, being drawn fo as that they may have that fort of eafy floping direction, by which the water can be taken off in a gradual manner. In this way there will not only be great advantage in the economy of labour in ploughing, nearly one third lefs power in the team being fufficient; but the injury and inconvenience of heavy rains wafhing down the foil and manure, are in a great meafure prevented. The author of "The Gentleman Farmer" mentions the inftance of a hanging field that had been carefully dreffed with lime and dung for turnips, and in which the turnips were fairly above the ground, when a heavy fatal fummer fhower fwept down the crop, together with the lime, dung, and a portion of the loofe foil, leaving the land bare and expofed.

On the method of forming ridges in lands that have fuch fituations, it has been lately well obferved, that when the fields hang fo much as to be accounted fteep, the ridges ought neither to be drawn parallel to the bottom of them, nor at right angles, ftraight up and down; either of which would be inconvenient in the ploughing, and injurious to the foil. They ought to be drawn diagonally. The great point is to underftand in what direction this diagonal flope of the ridges ought to run. In this refpect the cultivators in his diftrict are perfectly correct; and it is his wifh that their example were followed by all farmers whofe land has a great declivity, of which there is a confiderable proportion, not only in that, but in all hilly countries whatever. The form and direction of the ridges are, he obferves, contrived with fuch judgment, that the furrow (or, as Lord Kames with more accuracy calls it, the furrow

* See Marfhall's Rural Economy of the Midland Counties, vol. II. p. 18.

ſlice) falls eaſily away from the mold-board, as well in aſcending as in deſcending the field, which is the principal ſecret. There can, ſays he, be no more than two diagonal lines in any four-ſided figure, which is generally the form of incloſures; and if you bring a ſenſible ploughman to each of the angles below, deſiring him to look towards each of the oppoſite angles above, he will at once tell you, which of theſe diagonal directions is eaſieſt for himſelf and his horſes, and will accordingly fix on that line by which the furrow *in aſcending* will fall moſt readily into its place, having his right hand and the mold-board of his plough with a ſide-aſpect to the bottom of the field. But, in order to render this more plain, ſuppoſe, ſays he, the field to have a ſteep deſcent and a ſouthern aſpect, the ridges are drawn from ſouth-weſt to north-eaſt; which is the caſe in the inſtance alluded to. Suppoſe again, ſays he, the field to have a northern aſpect, the ridges are drawn in the ſame direction, but with this difference in ploughing, that you *aſcend* ſouth-weſt in the laſt caſe, whereas you *deſcend* ſouth-weſt in the firſt. If the field fronts the eaſt, you aſcend north-weſt; if the field fronts the weſt, you deſcend north-weſt; or invariably four points forward from the ſlope of the field, in going up the hill.*

It is further remarked by the ſame able writer, that if, on the contrary, the ridges be made parallel to the bottom of the field, all the dexterity of man and the force of cattle that could be applied, would be inſufficient to turn every ſecond furrow up againſt the hill. The expedient univerſally employed, according to the old ſyſtem, in ploughing fields of this kind, was, ſays he, either to plough with a double mold-board, or, if the mold-board were ſingle, to plough only one furrow, in going twice the length of the ridge; but moſt frequently the laſt. Both are bad huſbandry. In the former method you loſe none of your time indeed, but one half of your labour is loſt by the latter. His principal objection, he thinks, holds equally againſt both. All the ſoil is year after year rolling downward, and in proceſs of time the upper part of the field will be peeled to the bone, and quite bare of ſoil, while a great bank is accumulating along the bottom, like a dunghill, compoſed of the richeſt land in the field: and withal the furrows are laid ſo completely on their back, that little benefit is derived from the manure, excepting it be laid on the ſurface the firſt year.

He alſo adds, that where a hill is to be dreſſed, in order to be laid down into graſs, it ought to receive the laſt furrow by going round in a ſpiral line, without ever turning the plough, beginning at the baſe, and ending at the top;

* See Dr. Robertſon's Survey of the County of Perth, p. 124.

as by this method lefs labour is required, and the appearance of the land is more beautiful. But in the preparation of the ground for this laft furrow, it may be ploughed diagonally, with the view of keeping the foil from falling to the bottom, as has been noticed above; and in this intention the furface of the hill may be conveniently divided into three or more fections. Befides, in this way, no more ftrength of team is required in ploughing fuch elevations, than in that of ploughing on a level, while where the foil is of the gravelly or fandy kind, the great inconvenience of the moifture going off too quickly, is guarded againft by its being detained in the furrows*. This fpiral method of laying the furrow flices, is likewife recommended by the firft writer, as the neateft for finifhing off a lawn or pleafure-ground, near a refidence, even where the land is flat, as it brings the whole furface to a regular uniform appearance, and prevents the unpleafant effect of furrows on the eye.

On fuch lands as are level, or have but little inequality of furface, the beft general practice is, to form the ridges as ftraight and as regular in refpect to breadth as poffible, as by having them crooked, and of irregular breadths, the water is not only liable to ftagnate and injure the foil, but the friction in ploughing is greatly increafed, and the furrow flice is not fo well laid over, being more difpofed to fall back. And befides, many unneceffary turnings are requifite, on account of the inequalities of breadth, by which much time is loft, as well as much trouble given to the ploughman.

In old cultivated lands, where high, crooked, and irregular ridges are frequently met with, it often becomes neceffary to have them altered, fo as to render them more ftraight and level †. This is, however, a matter of more diffi-

* See Gentleman Farmer, p. 75.

† Mr. Donaldfon obferves, that in various parts of Great Britain, and efpecially in the more fertile and populous diftricts, the ridges are remarkably crooked, unequal in breadth, and made to rife towards the middle, or crown, to the height of feveral feet above the furrows on either fide. And that it is obvious that thefe are formed in the worft manner, to anfwer the purpofes which are now intended by dividing a field into ridges. It is not, however, he conceives, to be fuppofed, that this could have efcaped the obfervation of all the farmers of former times. On the contrary, from the practice having been fo general, it is more than probable that this form of ridges, which is now confidered as abfurd, was once deemed, like many other ancient practices, an improvement; for on many of the hills in Scotland, where the lands are dry and tolerably level, and where cultivation had, no doubt, taken place at the earlieft period, although now abandoned to the growth of heath (ling), the ridges are as ftraight as any in the beft cultivated parts of the ifland. The reafons which induced the farmers of former times to form the ridges in the manner which now appears fo objectionable, may, he fuppofes, be explained in

culty, and which demands more knowledge and care in its execution, than is commonly ſuppoſed. The moſt ſuitable period for accompliſhing the work where the plough is employed, is when the land is undergoing a courſe of repeated ploughings, as in the caſe of a fallow; as under ſuch circumſtances the more elevated parts of the field may be ploughed over as often, and in ſuch directions, as is moſt ſuitable for bringing them into a level ſtate. Where the ridges are not raiſed to any very conſiderable height in their middles, but badly formed in other reſpects, they may ſometimes be readily brought into proper order by being ſplit, or cloven down occaſionally; a mode which is performed by beginning at the furrows, and terminating at the crown, or middle of the ridge, ſo that the former furrows become the crowns, and the new furrows are made in the middle of the old ridges, which being filled by a furrow from each ſide, has the tendency of ſoon bringing them into a more equal and level form.

Where the ſoil is of the light, gravelly, or open and mellow kind, the plough may be conveniently employed in levelling the ridges, without producing any injury of conſequence to the crops that may afterwards be put upon the land. It is proper, however, even in lands of theſe kinds, to uſe much caution in performing the operation, in order to avoid the injury that might be cauſed by too large a proportion of the under-ſoil being brought to the ſurface in different parts of the ground.

It is aſſerted, by Dr. Anderſon, that where this is done by ſuch implements as are contrived for expeditiouſly bringing them to this ſituation, as ploughs, harrows, drags, &c. the farmer of neceſſity buries all the good mold that was on the top of the ridges in the old furrows; by which he greatly impo-

the following manner: When the lands were generally cultivated in the open field, or run-ridge ſtate, the furrows of the ridge were commonly the march between one farmer and another. The portion of land belonging to each tenant in any one place was thus ſo ſmall, as to prevent him from uſing any other method of draining, than that of raiſing the ridge ſo high as to allow the water to run off in the furrows, without doing damage to the crop. All the ridges which are broader at one end than the other, will, he thinks, generally be found narroweſt at that end of the ridge which is ſtill moſt wet and ſpouty. It is, therefore, more than probable, that the ridges were purpoſely made narrow at that end, as the only means by which lands ſo poſſeſſed could be drained. As the moſt crooked ridges are on ſteep and ſloping grounds, it may be preſumed, that prudence directed the firſt cultivators to adopt that poſition of ridges, in order to prevent the ſoil from being waſhed away by ſudden falls of rain; which would no doubt have been the caſe to a greater degree, had the ridges been all ſtraight. Each furrow becoming a ſmall rivulet, and having nothing to impede its courſe, muſt have done more injury to the ſoil than if it had run off in the circuitous courſe formed by the crooked ridges.

verifhes one part of his field, while he too much enriches another; infomuch, that it is a matter of great difficulty, for many years thereafter, to get the field brought to an equal degree of fertility in different places: which makes it impoffible for him to get an equal crop over the whole of his field, by any management whatever: and he has the mortification frequently, by this means, to fee the one-half of his crop rotted by an over-luxuriance, while other parts of it are weak and fickly, or one part ripe and ready for reaping, while the other is not properly filled; fo that it were, on many occafions, better for him to have his whole field reduced at once to the fame degree of poornefs as the pooreft of it, than have it in this ftate. An almoft impracticable degree of attention in fpreading the manures, may indeed in fome meafure, he thinks, get the better of this difeafe; but it is fo difficult to perform this properly, that he has frequently feen fields that had been thus levelled, in which, after thirty years of continued culture and repeated dreffings, the marks of the old ridges could be diftinctly traced when the corn was growing, although the furface was fo level that no traces of them could be perceived when the corn was off the ground. But this, he obferves, is a degree of perfection in levelling that cannot be ufually attained by following this mode of practice, and therefore it is but feldom feen; for all that can be expected to be done by any levelling machine, is to render the *furface* perfectly fmooth and *even* in every part at the time that the operation is performed: but as in this cafe the old hollows are fuddenly filled up with loofe mold to a great depth, while the earth below the furface, upon the heights of the old ridges, remains firm and compact, the new-raifed earth, after a fhort time, fubfides very much, while the other parts of the field do not fink at all; fo that in a fhort time the old furrows come to be again below the level of the other parts of the field, and the water, of courfe, is fuffered in fome degree to ftagnate upon them, infomuch that in a few years it becomes neceffary once more to repeat the fame levelling procefs, and thus renew the damage that the farmer fuftains by this pernicious operation.

On thefe accounts, if the farmer has not a long leafe, it will be found in general, he thinks, to be more for his intereft to leave the ridges as he found them, than to attempt to alter their direction: and if he attends with due caution to moderate the height of thefe old ridges, he may reap very good crops, although, perhaps, at a fomewhat greater expence of labour than he would have been put to upon the fame field, if it had been reduced to a proper level furface, and divided into ftraight and parallel ridges.

But where the land is of a clayey, loamy, or more tenacious and wet quality,

there will be more difficulty, as well as more attention required, in levelling and changing the ſhape of the ridges; as it frequently happens that in ſuch ſorts of ſoil, after the earth from the crowns has been removed in order to render the ridges level, eſpecially where done by mechanical means, a coarſe, unfriendly, ſtiff ſoil, is brought up, that requires ſo great a length of time, and ſo much amelioration to bring it into a ſtate capable of ſupporting good crops, as can not be compenſated by the advantages that may be obtained by the improvement in the form of the ridges; beſides, it is ſeldom poſſible to accompliſh this on ſuch ſoils without the danger of doing great injury by poaching. Hence it has been recommended not to be attempted, except in caſes of conſiderable length of leaſe*.

It may, however, in particular inſtances, be neceſſary, and highly beneficial, to have the buſineſs performed, though it ſhould be attended with much trouble and expence, which in diſtricts where labour is cheap may probably be beſt executed by means of the ſpade, as in this method the vegetable ſurface mold may ſtill be preſerved on the top for the reception of the crop, and no injury be ſuſtained by the bringing up of the ſub-ſoil. From the loſs and inconvenience that attend this proceſs, where machines are employed, Dr. Anderſon adviſes that they be wholly laid aſide, and that the following practice, which he has found ſucceſsful, be had recourſe to.

When the buſineſs is to be done, let a number of men be collected with ſpades, and then ſet a plough to draw a furrow directly acroſs the ridges of the whole field, intended to be levelled. Divide this furrow into as many parts as you have labourers, allotting to each a ridge or two, more or leſs, according to their number and the height of the ridges. Let each of the labourers have orders, as ſoon as the plough has paſt the part aſſigned him, to begin to dig in the bottom of the furrow that the plough has *then* made, about the middle of the ſide of the old ridge, keeping his face to the old furrow, working backwards till he comes to the middle of the old ridge, going deeper as he proceeds, according to the height he has to bring down; then let him turn towards the other furrow, and repeat the ſame on the other ſide of the ridge, ſo as to leave the bottom of the trench he has thus made acroſs the ridge entirely level, or as nearly ſo as poſſible. When he has finiſhed the part of the furrow allotted to him, which the plough has made in going, let him then go and finiſh in the ſame manner his own portion of the furrow, which the plough makes in return-

* See Gentleman Farmer, p. 76; and Anderſon's Eſſays, vol. I.

ing. It is obferved, that the old furrows ought to be raifed to a greater height than the middle of the old ridges, fo as to make allowance for the fubfiding of the loofe earth with which they are filled.

It is alfo recommended, that thefe temporary or crofs ridges be made 40 or 50 yards broad at leaft: for, although fome time will be loft in turning at the ends of the broad ridges, the advantage that is reaped by having few open furrows is more than fufficient to counterbalance this lofs: and, in order to moderate the height that would be formed in the middle of each of thefe great ridges, it will always be proper to mark out the ridges, and draw the *furrow* that is to be the middle of each fome days before the labourers are collected to level the field, to prevent any hurry or lofs of labour in the future operation of levelling. This breadth may be proper, where the land is fufficiently dry, but in wet, ftiff foils, it fhould be much lefs *.

* The following eftimates, though greatly below the prefent price of labour, may fhew the advantages of the different modes in refpect to expence:

Suppofing the price of labour in Scotland to vary in different places from fix pence to one fhilling; and that the medium price be fixed at nine pence per day; and that the hire of a plough, with four horfes and two fervants (for fo many, in general, will be requifite to labour properly ground in the condition that this is fuppofed to be in), varies in like manner from three to five fhillings per yoking, and that the medium price of this be called four fhillings; in this cafe, the comparative expence of levelling, by thefe two different modes, would, the doctor fays, be as follows:

Eftimate of Expence of levelling by the Spade.

	£	s.	d.
For wages to eleven labourers one day, at nine pence each, - -	0	8	3
For the hire of a plough $2\frac{1}{2}$ yokings, at four fhillings each, -	0	10	0
Total expence of one day's work,	0	18	3

Eftimate of Expence of levelling the fame by the Plough and Harrows.

	£	s.	d.
For 2 yokings and a half of a plough, as before - - -	0	10	0
For harrowing ditto, fuppofed at 1-4th of the ploughing, -	0	2	6
Total for once ploughing, &c. -	0	12	6
The fame five times more repeated,	3	2	6
Total expence of levelling by plough and harrows, - -	3	15	0
Total expence of levelling by the fpade, - - -	0	18	3
Difference, —	2	16	9

But though the levelling in this way may have been performed in the moſt perfect manner, ſomething further is, it is obſerved, required to bring the land into the moſt proper condition; as the earth below the plough furrow, at the crown of the former ridges, is ſolid, while that by which the former ſide furrows has been levelled is looſe, there muſt be a prejudicial inequality that is neceſſary to be obviated. This is recommended to be removed by employing a foot-crow, to dig and looſen the earth below the ſurface plough furrow in the middle of the former ridges, as much as poſſible, without turning it up. By this means, and leaving the former furrows a little more elevated than the old crowns of the ridges, the operation will be very complete *.

There are other methods in which this operation may be well and conveniently performed. It has been propoſed, by Dr. Robertſon, in his valuable Report of the State of Agriculture in the County of Perth, to begin the proceſs by removing the *made* or meliorated ſoil, on the crown of the ridge, to one ſide; which may be done by two or three ploughings in one direction, turning the furrow always one way. This is eaſier, he thinks, than doing it with the ſpade. Then ſuch a quantity of the buried ſoil may be caſt with the ſpade from the crown of the ridge, as will fill up the furrows at pleaſure: and laſtly, the meliorated ſoil may be ſpread over the ſurface of the whole. If it is not thought enough to ſave the meliorated ſoil on the crown of the ridge alone, firſt one ſide of the ridge may be taken, and then the ſame proceſs repeated on the other; by which means almoſt all the wrought ſoil may be kept on the ſurface. A good ſummer fallow, a hearty doſe of lime, and the mixture of wrought mold, will, he ſays, re-animate the new ſoil, and reſtore its vegetative power to its primitive ſtate; and a very few ſeaſons will naturalize the whole ſoil, while the farmer has the advantage of ſtraight ridges, moderately raiſed.

When the ſituation of a field is ſuch as to render it incapable, or very inconvenient, to be ploughed acroſs, a method, but which is leſs perfect, may be employed; which is, firſt to *cleave* out each ridge in ſuch a way, as to leave an open furrow in the middle of it; in doing which, about a yard on each ſide of the old furrow ſhould be left untouched, which, when the whole field is ploughed over, will conſtitute ditches of ſome depth between the ridges. The labourers are then to be ſent into the field with ſpades, in order to dig out trenches in the openings in the middle of the ridges, of depths proportioned to their heights, the earth thus removed being thrown into the furrows on the ſides.

* See Anderſon's Eſſays, vol. I.

After the whole has been dug out in this manner from one to the other, the plough is to be again made ufe of to turn back a furrow of the furface mold from each fide into the new-formed trenches; the diggers then beginning again to work in the bottom of this new-formed furrow, throwing the earth conftantly into the hollows between the old ridges. If by thefe means they be not fufficiently raifed, another furrow muft be turned back into the trenches, and another new one dug out after it, repeating fuch ploughings and diggings alternately, as often as may be found neceffary for the purpofe. The whole being in this way brought to a proper level, it fhould be harrowed acrofs, if the plough cannot be ufed, in order to blend all the materials of the foil as well together as poffible.

The expence of performing the bufinefs in this manner, is rather more than in the former method, as well as the levelling lefs completely effected; fo that, unlefs where a fuitable number of labourers for managing cannot be obtained, or fome other matter intervenes, the other method will always be advifable in preference to it. Yet this is much better than any of thofe methods ufually made ufe of with machinery*. It is obferved, that by either of thefe two methods the farmer has the fatisfaction of getting his ground reduced to a proper evennefs at once, fo as to reap the full benefit of a fummer-fallow, or any other operation that he may think proper. But as the earth below the furface muft for fome time be unequally firm, as has been already fhewn, it will be neceffary to lay it into narrow ridges for fome years at firft, and keep the furrows perfectly open and clean, to prevent, as much as may be, the water from ftagnating too much among the loofe porous earth that fills up the old furrows. In this view, the *two-bout* ridges, as they are called, may be the moft advantageous when they can be eafily and perfectly formed.

But as the plough, when judicioufly employed, is by much the moft eafy and expeditious method, and alfo that which can be the moft generally made ufe of, on account of the fcarcity of labourers, in many fituations, it will be proper to attempt the bufinefs by that implement, before the more expenfive one of the fpade be had recourfe to. And by directing the plough in different lines of direction, according to the particular circumftances of the cafes, it will be found to anfwer the intention in many inftances where the ufe of the fpade might at firft feem to be neceffary.

Ploughing.—This, or fome other method of loofening and turning up the fupe-

* Anderfon's Effays, vol. I.

rior parts of foils, is conftantly requifite in order to render them fuitable for the reception of the feed or crop that is to be cultivated. It is by means of this kind that a convenient bed for the roots of the young plants, and a proper condition of the land for fupplying them with due nourifhment, is in a great meafure provided, as well as a proper ftate of drynefs in many cafes afforded. Hence, in performing the operation, it becomes a matter of confiderable utility and importance to the agriculturift, to pay particular attention, not only to the ftate and nature of the ground, but alfo the feafon of the year, and kind of crop that is to be grown, as in this way he may frequently render the preparation of his lands more perfect and fuitable, and at the fame time obviate fome of the natural defects under which they may labour. Thus, in almoft every defcription of foils, ploughing them up before the latter part of the autumnal, or beginning of the winter feafon commences, renders them capable of imbibing and retaining a large proportion of moifture for the fucceeding fummer; while the turning them up during the fpring and fummer, caufes much wafte and difcharge of moifture, by evaporation and other means. Therefore, where the foil in its natural ftate is too dry, and poffeffes too little tenacity for the growth and fupport of fuch crops as are neceffary to be put into the earth in the fpring months, the land, by being fully brought into a ftate of preparation for the crop in the autumn, and the feed introduced without any additional ploughing in the fpring feafon, may be preferved in a more moift and adhefive condition, confequently in a more proper ftate for the growth of fuch crops; but where the foil is naturally moift, and the crops that are to be cultivated require that it fhould be dry and mellow, when they are put into the ground, the ploughing, by being deferred for the winter, and performed as late as poffible in the fpring months, when it is become a good deal dried, will be the more advantageous for the crops that are to be grown upon it.

But, befides thefe, there are other circumftances that conftantly demand notice in the practice of ploughing land. In all the ftiff, heavy, and more adhefive kinds of foils, that are much difpofed to the retention of moifture, whether they be perfectly clayey, or have more of a loamy quality, it fhould be a common rule never to plough or turn them up when wet in any great degree, except where the nature of the crop requires it; as when fuch forts of land are ploughed under fuch a condition, the parts of which they are compofed are very apt to cake and run together into hard lumps, that require much trouble and difficulty to be afterwards reduced into a fine ftate. And further, great injury is produced by the treading of the team, as well as a much greater

power neceffary in performing the operation. But, at the fame time, they fhould not be permitted to become fo dry and hard as to afford too great refiftance in that way, before the operation is proceeded upon. Some, however, fuppofe, that all thofe foils in which clay prevails over the other ingredients may be ploughed even when wet, without any injury being done, if the bufinefs be accomplifhed before the fetting in of the winter frofts; but that the teams had much better remain totally idle than draw a furrow in the fpring, until the ground be in a fufficiently dry ftate *.

The marfhy, moory, and peaty or moffy defcriptions of foils are in general, when in a ftate of tillage, to be ploughed when the feafon is dry, as they can feldom be wrought to advantage, and frequently not at all, when they are wet to any confiderable degree.

But in the dry, fandy, and probably in fome of the more mellow and friable kinds of loamy foils, the bufinefs of ploughing, efpecially for the putting in of the feed, may be performed when they are in a ftate of confiderable moifture, not only without their fuffering any inconvenience, or the feed being injured, but often with advantage, as they are liable to part with the watery particles that they contain too readily. On this laft account the very dry forts of fandy land fhould, whenever the weather is hot and dry, merely be ftirred in fuch way as may be neceffary to prevent the growth of weeds, otherwife the great exhalation of moifture in fuch feafons may render them too dry for the healthy vegetation of the feeds or plants that may be fown or fet upon them. The cultivators of foils of this nature have, therefore, many advantages over thofe who are engaged on the more ftiff and heavy forts of land, in being able to perform the various operations of arable hufbandry with much lefs ftrength and expence of team, and by being much lefs interrupted by the wetnefs of feafons.

In regard to the depth and frequency of ploughing lands, they moft conftantly depend, in a great meafure, upon the qualities and the fort of crops that are to be grown. But in general the different preparatory ploughings fhould be deeper than thofe of the feed furrow, which ought moftly to be light, and the flice not too much laid over, that the feed, efpecially where the broad-caft method of fowing is adopted, may be the more perfectly covered.

It is well obferved on this fubject, by an able practical writer, that though deep ploughing has been greatly recommended by fome modern writers, upon particular kinds of land, where the bottom and top are of two oppofite qualities, and

* Communications to the Board of Agriculture, vol. III. part i. p. 45.

neither of them perfectly good, that a mixture may fometimes be very beneficial, and the experiment of going below the common depth fometimes anfwer. But that where the top and bottom, for eighteen or twenty inches depth, confifts of the fame foil, he does not believe it is ever worth while to exchange the upper part, which has been enriched for centuries back, for a part lefs rich, merely becaufe it is more frefh. He has, indeed, he fays, obferved, that deep ploughing (except for fome particular grain and plants) is by no means neceffary. The vegetation of ordinary corn and grafs does not require any great depth. In many parts of *Cornwall* the land is, he affures us, exceedingly fruitful, though the foil is extremely fhallow; and in many other counties they find, by experience, that they ruin their land by ploughing below the ufual depth. Befides, when land is ploughed very deep, the roots of the weeds are only turned over and removed, and hardly ever thrown upon the furface to wither; but clean, fhallow ploughing diflodges and deftroys them much more effectually. Nay, hand-hoeing is, he remarks, allowed by every body to do more towards cleaning land than a ploughing. And even the practice of burn-baking, he contends, effectually cleans land, though it only goes two inches deep. This feems, he fays, to fhew that very deep ploughing is by no means neceffary towards cleaning land: and it muft, he thinks, be univerfally allowed, that the longer we keep our manure within three or four inches of the furface the better; efpecially upon a light foil, from which it is apt to fink, and efcape too foon *. And doctor Anderfon, who has had much experience in this way, informs us, that though benefits may be derived from the opening up of the foil to a confiderable depth in fome cafes, it is by no means neceffary to attempt to plough, on ordinary occafions, to a great depth: on the contrary, unlefs it be for very particular purpofes, he is fatisfied that fhallow ploughing will, for the moft part, be more beneficial than the reverfe. In that cafe the furface foil, in which all feeds muft germinate, and draw their nourifhment for a confiderable period of their growth, will, he conceives, be rendered much more fertile by the fame quantity of manure, than if it were mixed with a much greater depth of mold; and as it is known that the fertilizing qualities of all manures are carried downward by moifture, where the foil is fo porous as to admit of a flow abforption of that water, the under-foil will gradually become more fertile by this procefs, which will tend to nourifh the crop. On retentive foils, where the practice of loofening them to fome depth by other implements is omitted, deep ploughing is, however, he conceives, extremely neceffary.

* Kent's Hints.

It is further remarked by the firft author, that upon all light foils it is neceffary to preferve, at fix or eight inches below the furface, what farmers call a *pan;* that is, the ftaple, at that depth, fhould be kept unbroken; by which means manure will be kept longer on the top: and in dry feafons the lefs depth the pan has, the lefs liable the corn will be to burn, provided the pan confifts of earth, and not of rock; becaufe the roots of the corn will, he thinks, find more moifture by ftriking againft a body of clofe earth than they will in a greater depth of hollow earth; as it is evident the former preferves more moifture in dry feafons. And that another advantage which is obtained from this pan is, he conceives, the having a lefs quantity of mold to work and keep in heart. Where very deep ploughing is practifed, this bottom, or pan, muft be deftroyed; and much more manure will be required in that cafe, he fuppofes, to keep the ground in good condition, and fit for the growth of crops.

In regard to the frequency of ploughing or turning over ground, in order to prepare and render it fuitable for the production of good crops, it is obvious there muft be much difference according to the nature and condition of the foil, as well as the kind of crop that is to be grown. The ftiff, clayey, loamy, and even chalky foils will, in general, ftand in need of more frequent ftirring, either by means of the plough, harrow, or fome other implement, in order to feparate and break down their tenacious particles, than thofe of the fandy or gravelly, and more light kinds, in which there is much lefs adhefion. Befides, where lands have been in a courfe of tillage for fome length of time, whether they are of a clayey, loamy, or even fandy quality, they may require lefs frequent ftirring than where the contrary is the cafe. And where the method of putting the feed into the ground by means of drill machines is to be had recourfe to, a fine ftate of tilth will, in general, be indifpenfably neceffary.

The nature of the crop that is to be cultivated muft, however, in moft cafes, direct the number of ploughings that may be neceffary, as fome demand a much finer ftate of tillage than others; though in moft cafes a well-reduced earth is favourable. It has, indeed, been afferted, that the finer land of any kind is made by tillage, the richer and more capable of fupporting plants it becomes. A proof of which may often be met with in lands where a part has, from accident or other caufes, been better tilled than the reft, as, though they be afterwards conftantly managed in precifely the fame manner, the part fo treated always affords better crops than thofe which have not had the advantage of fuch tillage *.

* Tull's Horfe-hoeing Hufbandry, 8vo. edit. p. 44.

Where the nature of the crop is fuch as to be greatly retarded and injured in its growth, by the occurrence of other plants, as in wheat and barley, the land will conftantly require to be rendered fine and mellow, either by frequent ftirring by the plough, or the growing of fuch preparatory crops as have a tendency to bring it into a friable and clean ftate, by the fhade which they produce, and the repeated tillage and culture which they receive while growing. And where fuch plants as produce large, knobby, or tap roots, in or upon the foil, are to be grown, it will be neceffary to have the land well broken down, and rendered mellow by repeated turning over, in order that they may more readily pufh down, or extend themfelves in other directions. Befides, it has been feen that a fine ftate of tilth is always the moft favourable for affording the nourifhment and fupport of crops in a free and equal manner*, both on account of its admitting the fibrous roots of the plants to fpread and extend themfelves with more facility, and the manures to become more minutely divided, and more intimately blended with the foils; as well as from the fubftances that conftitute the food of the plants being more readily and more copioufly formed by the chemical combinations and decompofitions that take place under fuch circumftances. And further, by means of fuch degrees of pulverifation and mellownefs, the feed, efpecially when it is of the fmaller kind, is not only more equally and more perfectly covered, but its vegetation more quick, from its becoming more fully in contact with the mold, and from the moifture being more minutely diffufed and retained in the ground, which is an advantage of much importance in the cultivation of many forts of crops.

In the choice of implements for the performance of this bufinefs, the agricultor fhould be careful that they are well fuited to the nature and quality of the land, as it is not poffible that any particular fort of plough can be employed with equal facility and advantage on foils of different defcriptions. The clayey, and all the more ftiff and heavy kinds of land, will require ploughs of more ftrength than thofe of the thin chalky, and a light, fandy, or gravelly nature. The former may moftly be managed in a proper manner by any of the well-conftructed kinds of ftrong ploughs, as the *Suffolk iron fwing-plough*, &c. and the latter by thofe of the light fort, as the *Rotheram plough*, *Small's chain-plough*, &c †. But whatever defcription of plough may be had recourfe to, it is a matter of the greateft confequence that it be properly formed and attached to the draught, as where thefe points are not minutely attended to, there muft conftantly be

* See fection on Fallowing of Land. † See fection on Implements.

a confiderable lofs in the economy of labour and time, as well as in the completenefs of the work. With fuch ploughs as have a fuitable form and conftruction for paffing through the earth without affording unneceffary refiftance, any of even the heavier forts of foil may be ploughed with little more than half the ftrength of team that is employed where the contrary is the cafe. It has been lately found, that in a light loamy foil, Small's plough, with two horfes a-breaft, and the ploughman driving by means of rope reins, was capable of performing its bufinefs with equal readinefs, and to a greater depth when requifite, than the ordinary ploughs of the diftrict with four horfes, a ploughman, and a boy as a driver. This advantage, it is conceived, arifes from the "fymmetry of its parts, and the formation of the mold-board, which is of caft-iron, and fo conftructed as to afford the leaft poffible refiftance in paffing through the earth; and in giving the horfes the greateft purchafe in their draught, by placing them near the plough *." But it is remarked further, that "the leaft variation in the formation of the mold-board, or in the proportional diftance of the refpective parts," is capable of deftroying the effect; which further proves the neceffity of clofely attending to what has been mentioned above.

Harrowing.—This is a procefs in tillage that becomes ufeful after ploughing has been performed, both with the view of breaking down and reducing the particles of the foil, fo as to aid the pulverifation that has been effected by the plough, and that of dragging out and clearing the land from root and other weeds that may have commenced their growth, as well as for the purpofe of covering the feed.

In the two firft intentions the fize and weight of the harrows, and the length of the tines, or teeth, fhould in moft cafes be confiderably greater than where the covering of the feed forms the principal object. And where the land has been laid in a rough manner by the plough, and there are many weeds of the root kind, it will be more advantageous and effectual to have harrows paffing in a direction contrary to that in which the ground has been ploughed, as by that means more weeds will not only be eradicated, but the parts of the foil be more fully and more completely divided, broken down, and reduced. And where feed-weeds are to be eradicated, the furface fhould conftantly be, at firft, made as fine and fmooth as the nature of the land will admit, by harrowing, to promote their more rapid vegetation, in order that the fubfequent operations of the fame kind may clear the land in a more perfect manner. Drags, fcari-

* Campbell in Communications to the Board of Agriculture, vol. III. p. 233.

fiers, fcufflers, cultivators, and what are termed fixed harrows, are often very effective implements in thefe different intentions where the foils are of the more ftiff and obftinate qualities. Tines of different conftructions, according to the circumftances of the land, are alfo fometimes employed with confiderable benefit, in breaking and reducing the hard and cloddy condition of very tenacious and ftubborn foils that have much of the clayey or ftrong loamy property.

Where the defign of the farmer is only to have the feed covered by the operation of harrowing, it will not be lefs neceffary to have the furface part of the foil, after the feed has been fown, rendered as fine and mellow as the quality of the land will allow, as where this is neglected the moifture is not fo perfectly diffufed through or retained in the mold, nor the nourifhment fo equally fupplied, confequently the vegetation and growth of the crop muft be more flow and imperfect. It is however remarked, by an intelligent writer, that though "it is obvious that ftrong land requires more harrowing, in order to reduce it to a pulverifed ftate, than lighter foils; yet as all foils are rendered more firm and folid by harrowing, the lefs a ftrong foil is harrowed, if the intention is anfwered, the better. On the other hand, light fpongy foils, efpecially where there is any portion of mofs (peat), being rendered more compact and retentive of moifture by harrowing, can fcarcely get too much *."

It fhould likewife be noticed, that in all the more heavy and retentive kinds of foil, operations of this fort, as well as thofe of ploughing, fhould be as little as poffible performed when the feafon is inclined to be wet; while in all thofe which are of a fandy, or open, porous nature, they fhould be practifed as fparingly as the circumftances of the cafes will admit, when it is very hot and dry; as in the firft, great injury and difadvantage muft arife from their poaching, and becoming mortary; and in the latter from the too great evaporation and diffipation of moifture.

In refpect to the manner of performing the procefs of harrowing, when the feed has been fown, the common method, according to the author juft mentioned, is firft along the ridges, then acrofs, and then along again. When the ridges are level, or nearly fo, they may, he obferves, be harrowed either way as the farmer may find moft convenient, it being of little confequence whether the harrow go firft acrofs or along the ridges of a well-ploughed field in proper tilth; but if the ridges are raifed in the middle, and the land indifferently ploughed, it would be highly improper to begin by harrowing acrofs,

* Donaldfon's Modern Agriculture, vol. I. p. 51.

as thereby a confiderable fhare of the feeds would fall into the bottoms of the furrows, and be prevented from vegetating.

There is ftill another circumftance, he remarks, in regard to harrowing, which, as it is frequently of very material importance, ought not to be omitted. It often happens, that after a field has been properly fummer-fallowed, manured, and prepared in the beft manner for fowing wheat, the farmer is prevented from fo doing by heavy falls of rain. Though no water may appear on the field, yet it is rendered fo poachy, that he cannot put on his horfes for the purpofe of harrowing in the feed, and that circumftance alone prevents him from fowing his wheat in due feafon. In fome parts of Scotland a method has been tried to remedy this inconvenience; which, when the ridges are ftraight, and not over broad or too high raifed on the crown, has, he fays, been found to anfwer beyond every expectation that could be formed. It is as follows: An axle, equal in length to the breadth of the ridge, is fixed on two cart-wheels; and to this axle is chained as many harrows as will cover the breadth of the ridge. To each of the ends of the axle two horfes are yoked, and made to walk along in the furrows of the ridge; the wheels turning eafily round, and following the horfes in the furrows: the horfes feet are, by this expedient, prevented from doing any injury, and the feed is as effectually covered as in the ordinary way. It is neceffary, however, he fays, that the harrows fhould not be turned fhort at the end of the ridge. But, to avoid confufion, it is better to go along one ridge, and return by another, which may be done as often as is judged requifite for harrowing the field in a fufficient manner.

But though crops may, by contrivances of this nature, be put into the ground in the moft proper feafon, under fuch circumftances, they muft often be liable to great injury, or even deftruction, from the abundant wetnefs; it would probably, therefore, be a better practice to have the lands prepared fo early as that the opportunity of a dry time might be afforded for harrowing in the feed in the ordinary way.

When grafs feeds are fown, the operation of harrowing fhould be performed only in a flight manner, and with a very light harrow, that has fhort tines or teeth; as where thefe circumftances are not regarded, they will be liable to be put in too deep, and their vegetation of courfe greatly retarded, if not wholly prevented.

Rolling.—This is another operation in the tilling of land, that is equally employed for breaking down and reducing the foil to a fine ftate of tillage, and for levelling and rendering it fmooth, after the feed has been harrowed in. In

the ſtiff, heavy, and adheſive ſoils of different kinds, the roller may frequently be made uſe of, in the firſt intention, with very great advantage ; but it ſhould only be employed when ſuch lands are tolerably dry, for when drawn over the ground under the contrary circumſtances, little benefit can be afforded in the way of pulveriſation, while much miſchief muſt be produced by the poaching of the horſes, and the plaſtering of the earth round the implement. But by uſing it in the manner juſt directed, all the lumpy or cloddy parts of the ſurface ſoil may be effectually cruſhed and reduced into a fine powdery ſtate, fit for the reception of the ſeed. Or if in ſuch ſorts of ſoil it be applied in the intervals between the different harrowings, it may contribute much in the ſame way, not merely by reducing a great number of the lumps by the preſſure that it cauſes, but by forcing others ſo much into the ground that they may be acted upon and further broken down by the fermentation that moſtly takes place in the ſoil after land has been ſtirred. In all the light and more porous ſorts of ſoil, very beneficial conſequences may alſo be derived from this operation, by the conſolidation of ſurface that is thus produced, and the more perfect retention of moiſture, by which the ſeed, eſpecially if of the ſmall kind, is enabled to vegetate more equally, as well as in a more expeditious manner.

In caſes where land has been left rough after ploughing, for the purpoſe of more effectually deſtroying root weeds, it may alſo be of utility, by being employed before the harrows, to give them more power in laying hold of and reducing the ſoil. And by the pulveriſation that it affords, and the more perfect retention of moiſture that it cauſes in conſequence of the ſurface being rendered more cloſe and compact, the ſeed-weeds are produced more abundantly, and more readily deſtroyed. It is likewiſe in theſe laſt methods that it proves ſo highly beneficial in all caſes where graſs ſeeds are ſown ; as well as by the equality and ſmoothneſs of ſurface that is thereby produced *. It is well obſerved, by the ſame writer, that if no other benefit were derived from rolling lands in tillage than ſmoothing the ſurface, even that in harveſt is of material conſequence, more eſpecially where the crops are cut down with the ſcythe, which is general in moſt of the ſouthern diſtricts of the kingdom, and which the increaſing ſcarcity of labourers muſt ſoon, in all probability, introduce into thoſe of the north.

Manuring.—In the application of manures to lands in the ſtate of tillage, conſtant attention will not only be neceſſary to the nature and quality of

* Modern Agriculture, vol. III. p. 55.

the ſoil and manure, but to the kind of crop that is to be grown with it, and the ſeaſon of the year, as well as the manner of its being laid on the land. Without proper management in all theſe reſpects, much expence and waſte of manure may often be incurred to little or no advantage. For, from what has been already advanced, it is ſufficiently evident, that ſome particular ſorts of manures are better ſuited, and more capable of producing beneficial effects on ſome kinds of land than others*. Thus, on the ſtrong, clayey, or loamy ſoils, thoſe of the animal or dung kinds, and which are capable of affording large proportions of ammonia or carbonaceous matter in proportion to their bulks, and ſuch ſubſtances of the calcareous kind, whether burnt into lime, or uſed in their natural ſtate, as are the moſt friable, or have the leaſt tendency to bind and cement the particles of ſoils together, are the moſt ſuitable and proper. And other matters, ſuch as ſand, and many ſimilar bodies, that are capable of dividing and ſeparating the parts of ſuch ſtiff ſorts of land, may frequently be employed with great benefit in the view of altering the conſtitution and texture of them mechanically, though they poſſeſs little virtue in the way of manures. But thoſe kinds of materials that have any great diſpoſition to increaſe the ſtiffneſs and tenacity of the ſoils, muſt be carefully avoided. Hence clayey marle, and all the more ſtiff and tenacious earthy ſubſtances, as well as what are termed by farmers the hot ſorts of lime, are in ſuch caſes diſadvantageous and improper for the purpoſes of manure

Where ſand is employed on ſoils of this deſcription, it ſhould be laid on them where convenient, in proportions ſuitable to the tenacity and ſtiffneſs of the land, and under ſuch circumſtances of tillage as that it may be the moſt capable of being minutely blended with it.

The common ſand can, however, only be laid upon lands with the view of its altering their textures, ſo as to render them more mellow and proper for the growth of grain crops. Sea ſand will be found highly beneficial, not only in this view, but likewiſe in conveying a portion of fertility. But, from the ſaline matters that it may contain, it may be either laid immediately on the land, or be mixed with dung and other manures into a compoſt before this is done, according to the circumſtances under which it is laid on.

On the perfectly loamy ſoils, eſpecially where they are of the mellow and more friable deſcription, almoſt every ſort of manure that is produced on the farm may be made uſe of with benefit. But where they approach much towards the

* Section on Manures.

ſtiffneſs of the heavier ſorts of ſoils, clayey marles may be improper, and where they abound with calcareous matters, lime, chalk, and other ſubſtances of the ſame kind, ſhould be leſs freely employed.

In the application of manure to lands of the *marſhy* kind, when they are brought into a ſtate of aration, ſimilar attention will likewiſe be neceſſary. It has been obſerved, that where theſe ſoils are compoſed of a heavy, moiſt ſleech, a very ſluggiſh ſpecies of land is formed, on which the crop is lodged from year to year, before it arrives at maturity, which makes it of little value. A quantity of ſand from the beds of rivers, when laid on ſuch ſoils, enables them, however, to produce excellent crops of lump grain, which ſtands until they are cut down *.

But on the ſandy and all the lighter ſorts of tillage lands, ſuch manures as poſſeſs the property of promoting and augmenting the tenacity, or of bringing the particles more cloſely together, of retaining moiſture, and of affording ſtability to the roots of plants, will be the moſt favourable. In theſe views, clayey marle, the ſediments and depoſitions of ponds or rivers, loamy and peaty earths, &c. with farm-yard dung, may be had recourſe to with propriety.

In Suffolk, on the ſandy diſtricts, the earthy ſubſtance applied is generally a clay marle; though a pure, or nearly a pure clay, is preferred to very looſe ſands. But when the *clay* is not of a good ſort, that is, when there is none, or ſcarcely any clay in it, but it is an imperfect, and even a hard chalk, there are great doubts how far it anſwers, and in many caſes it has been ſpread to little or no advantage. The quantity uſual is from ſixty to eighty, and ſometimes one hundred loads an acre, the load containing about thirty-two buſhels. Many experienced farmers, however, prefer carrying forty or fifty loads only, and repeating it after the firſt courſe. The beſt mode of doing it, according to ſome, is to lay down the land with graſs-ſeeds for a couple of years, and then lay the clay upon the turf the latter end of the ſummer, and break up the land in the ſpring following, to ſet with peaſe, if the land be proper for that crop. It is, indeed, conceived, that one hundred loads per acre are, perhaps, not too much for newly cultivated heaths or warrens. But for other ſleet ſoils, which have been for a long time under cultivation, fifty, or at moſt ſeventy loads, are quite ſufficient.—On ſuch ſoils, to lay on too much is attended with great loſs. In this way the land receives more immediate benefit, and double the number of acres may be clayed in the firſt

* Agricultural Survey of the County of Perth.

years of the farmer's leafe, without any additional expence*. The duration, and indeed the whole effect, it is obferved, depends much on the courfe of crops purfued. If the plough be too freely ufed, and corn fown too often, it anfwers badly, and the effect is foon loft; but with good management it lafts twenty years. Where the management is good, and the clay well adapted to the land, the profit is alfo very great. In many cafes a courfe of fallow and rye, or *light* oats, is converted to fine barley, clover, and wheat, and the produce of the foil multiplied twenty-fold; but, on the contrary, the cafes in which the return has been inadequate, are not a few. And it is believed that it will be found, that on foils that will yield faintfoin, it is more profitable to cultivate grafs, than to clay the land for corn. There are various forts of clay in ufe; fome fo exceedingly ftrong and loamy, that they will not mix with the foil; others ftrong and full of particles of chalk; and another fort very tender, and which has a mixture of fand: the fecond is believed to be the beft; the ufe of it prevails very much at prefent, in the ftrong wet lands in high Suffolk, even where *clay* is ploughed up. Within a few years, the mixing clay with maiden earth and muck out of the farm-yards is very much practifed; and good farmers tell you, that muck fhould never be carried upon the land alone: the reafon of which it is faid is, that muck produces ftraw with little corn; but to grow a full crop of corn, compoft muft be ufed †.

It is alfo faid to be a great improvement in the applying of clay, or marle, to lands, to make ufe of fingle-horfe carts, inftead of the common tumbril, or heavy cart. Calcareous materials, both in their pulverifed raw ftate, and that of calcination, may in many inftances alfo be applied to foils of the above defcription, with very beneficial confequences.

It has, however, been well obferved, that previous to the application of either chalk, lime, or gypfum, particular attention fhould be paid to the nature of the fand. If it fhould appear to owe its origin to lime-ftone, marble, fhells, or other fuftances that admit of being burnt into lime, the addition of calcareous matter would, in moft cafes, be ufelefs. At all events, the application of thefe fubftances fhould be firft made on a fmall fcale, in order to afcertain the effects they would produce ‡.

Mofs or peat earth, either in a ftate of combination with farm-yard dung or

* In regard to the expence of this application, it is obferved, that the men are paid from 27s. to 30s. per one hundred and twenty loads, for filling and fpreading, earning 10s. or 11s. a-week; and the expence of teams is about as much more. When this manuring is done, therefore, on very poor land, the expence is nearly equal to the value of the fee-fimple of the eftate.

† Agricultural Survey of the County of Suffolk. ‡ See Middleton's Report of Middlefex, p. 145.

in its natural ſtate, has likewiſe been found highly uſeful. Upon light land, where there is a great proportion of ſand or gravel, the moſſy material naturally retains the rain and the dew, which that kind of ſoil could not naturally retain; and by this ſupply of moiſture, preſerves ſuch dry ſoils from the effects of ſevere drought. After it is ploughed in, it likewiſe not only acts as a ſponge, but forms an addition to the ſtaple of the land, which are circumſtances not to be diſregarded in the uſe of manures*. The manure produced by the turning in of ſucculent green vegetable crops, may alſo ſometimes in ſoils of this kind be attended with ſucceſs.

In the arable management of peaty, moſſy, or moory ſoils, the moſt advantageous application in the way of manure in the firſt inſtance will, in general, be that of lime, or ſome other of the ſubſtances that abound in calcareous matter, in large proportions, together with the aſhes that have been formed where the practice of paring and burning has been adopted in bringing them into cultivation. And after theſe have been well incorporated with the ſoil, farm-yard dung, where it can be procured, may be had recourſe to with great benefit. Clay, ſand, gravel, and various earthy ſubſtances of a ſimilar nature, may alſo often be made uſe of on ſuch ſoils with great utility in the way of rendering them more firm, and giving them greater compactneſs of texture†.

In the uſe of manures, beſides adapting them to the nature and properties of the ſoils, the agricultor ſhould be careful to apply them in ſuch ways as may be moſt ſuitable for the production of their fulleſt effects. In this view, the nature of the crop, the condition of the manure, and the mode of its application, are to be well conſidered; for it has been found from practical trials, that where particular ſorts of manure have either been naturally found in the ſoils, or artificially laid upon them, ſome kinds of crops may be grown and brought to perfection much more completely than where ſuch impregnations have not taken place; while on the contrary, other ſorts of crops can ſcarcely be produced at all until a different ſort of manure has been incorporated with the mold. Thus it is obſerved that the common pea, whether white or grey, cannot be reared to perfection in any field which has not been either naturally or artificially impregnated with ſome *calcareous* matter. And hence it is ſuppoſed to happen, that peas are rarely cultivated univerſally as a field crop, unleſs in thoſe parts of the country where either lime, marle, or chalk abounds, or upon ſtrong clays: except, indeed, on the ſea coaſt, where ſhell-fiſh are often catched in abundance, and where the fields are manured with their ſhells in a ſtate of mixture with dung. But it is remarkable, that a ſoil that could

* Agricultural Survey of Perthſhire, p. 297. † Ibid. 298.

fcarcely have brought one pea to perfection, although richly manured with dung, from their running too much to haum, and, after bloffoming, dying away without becoming ripe, if it has once had lime applied upon it, is capable, when properly prepared in other refpects, of producing plentiful crops of peas ever afterwards *. It is further remarked by the fame writer, on the refult of an experiment, in which the ridge of a field that had been miffed in liming produced no good wheat, while all the other parts afforded a full crop, that lime, or fome other calcareous material, is equally neceffary for the production of good wheat crops as for thofe of the pea kind. The general obfervation that the wheat, where this fort of manure has been employed, is thinner in the fkin, more plump, and yields better, feems alfo to favour the fame conclufion. Impregnations of this fort appear likewife, it is fuppofed, particularly favourable for the production of barley crops, much more fo, efpecially if in large proportions, than for thofe of oats.

But, on the contrary, turnip crops are found to be produced in the beft manner where the land has been enriched by means of dung; while lime, or other calcareous fubftances, do not promote their growth in nearly fo high a degree. This is alfo in fome meafure the cafe with cabbage, potatoe, and other crops of a fimilar kind. Hence it is concluded by the author juft mentioned, that turnips are the moft fuitable for firft improving crops in fuch diftricts as are deftitute of calcareous matter, and peas in thofe which abound with it.

As in the cultivation of different forts of crops there are fome that require large fupplies of nourifhment during the more early ftages of their growth, while others demand fmaller proportions, but to be continued with great regularity and evennefs for a confiderable length of time, it will be proper and advantageous to apply the manures in fuch ftates as may be the moft favourable for thefe purpofes. Thus, where thofe forts of luxuriant crops that ftand in need of much fupport in their early growth, fuch as potatoes, cabbages, turnips, carrots, peas, beans, and other fimilar ones, they fhould not only be laid upon the land in a lefs reduced ftate, efpecially where the lands are light, but be applied in fuch a manner as that the crops may derive the benefit of them in the moft full, equal, and expeditious manner. Hence in the two firft, as well, perhaps, as in fome of the other kinds, it may be the moft beneficial method to place it in drills with the fets or plants, and in the latter to be lightly ploughed, harrowed, or otherwife put in, immediately before the feed is fown. But as in the turnip, and other fimilar crops, from the fmallnefs of the feed, and

* Anderfon's Effays, vol. II. p. 302.

other circumftances, a much finer ftate of furface is neceffary than for the other kinds, it may be proper, efpecially where the manure is only harrowed in, to have it fhorter and more rotten than in the other cafes. It has alfo been remarked, that by depofiting the manures in drills, much advantage will be derived in the faving of fuch articles, as well as in the crops' being more effectually fupported, and confequently more productive. Befides, the manures in this way are more completely fecured againft the effects of evaporation *.

In the application of manure for grain crops, as they are frequently liable, efpecially in the better forts of foils, to be greatly injured by an over-luxuriant growth, where the dreffings are laid on for the immediate crop, it may be a better practice in fuch cafes to have them applied with the different preparatory fallow, or green crops, fuch as turnips, peas, beans, cabbages, carrots, &c. as in this way great advantages will be obtained, not only in the production of fuch crops, and their bringing the lands into the moft perfect order for the growing of grain, but in the manures being more fully and more completely blended and incorporated with the foils. Where the quality of the land is not very good, and the method of fummer fallowing is purfued, it may, however, in fome inftances, be a good method to apply the manures upon the fallows, both for the wheat and barley crops; as under fuch circumftances of the land, it is probable they are moft capable of being minutely blended with the foil, and confequently of affording the moft equal fupport to the grain. Where calcareous fubftances, fuch as fine chalk and the fhell marles, are to be made ufe of, it may alfo be the moft fuitable method to apply them when the lands have been reduced to a confiderable degree of pulverifation and finenefs, by ploughing, or other means; as under fuch circumftances they will be much better and more minutely divided and incorporated with the mold of the foils than could otherwife be the cafe, a point on which we have feen that much advantage depends in the application of fuch matters. Such materials are frequently laid on the land in their fimple ftates, and in making ufe of them at firft upon a foil, it may be the moft beneficial method; but where they are often repeated, the practice of mixing them with earthy or other fubftances may be more advantageous †.

But in whatever way or on whatever defcription of tillage land the manure of the farm may be principally applied, it fhould never at firft be depofited, or covered up too deeply, in the foil; as where a large mafs of earthy matter is placed upon the manure, the effects are not only much flower, but liable to be

* Experienced Farmer, vol. I.

† Section on Manures.

exerted when they cannot be of the moſt utility in aiding the growth of the crops. Beſides, as moſt of the ſubſtances employed in this way have much tendency to ſink down to the inferior and more ſolid parts of the ſoils below by the rains, and the neceſſary hoeing and ſtirring that muſt ſucceed, they will be ſooner out of the reach of the abſorbent roots of the plants which they are deſtined to ſupport, which for the moſt part only extend themſelves in a ſuperficial manner. They ſhould, however, in every caſe, be ſo covered or placed in the earth, as that the diſſipating proceſs of evaporation may be effectually guarded againſt.

In regulating the proportions or quantities in which manures ought to be applied to lands under the ſtate of tillage, various circumſtances are to be taken into conſideration, ſuch as the nature, ſituation, and condition of the land, the manner in which it has been previouſly employed, the kind of crop that is to be grown, and the ſtrength or goodneſs of the manure to be applied. In bringing different ſorts of land into cultivation, where they are naturally poor and thin in the ſtaple, or where they have been much reduced and exhauſted by injudicious modes of cropping, as well as where full crops of thoſe luxuriant vegetables that require much ſupport are to be cultivated, it will, in general, be the beſt practice to apply ſuch full dreſſings at once, as may be ſufficient to bring the lands into ſome ſtate of richneſs and improvement, and at the ſame time render them capable of ſuſtaining the crops that may be put upon them; as where ſmall quantities are only laid on at once in ſuch caſes, much loſs is moſtly ſuſtained in the poverty of the crops, as well as in the great length of time that is required to bring the lands into a ſuitable condition for the purpoſes of tillage.

In the applying of different ſorts of dung, and all thoſe manures that are in a ſuitable condition for immediately imparting to the earth ſuch ſubſtances as are proper for the nutrition and ſupport of crops, eſpecially where the principal object of the agricultor is the benefiting of grain, or ſuch other ſorts of crops as may be directly cultivated, and not that of the more diſtant advantage and improvement of the ſoil, conſiderable ſavings in the quantities of the manures may probably often be made, by laying them upon the land and blending them with the mold as nearly as poſſible to the periods of ſowing or putting in the crops; as in this way there will be but little loſs from the diſſipation or waſhing away of the nutritious matters before the crops are in a ſtate to be benefited by them, as muſt always be the caſe to a greater degree than is, perhaps, generally ſuppoſed, where the contrary practice is purſued. In this method, they may be employed with

great propriety to the wheat, barley, pea, or turnip crops, by being equally ſpread out upon the prepared land, and then turned into it by means of the ſeed furrow, which in ſuch caſes ſhould in general be very light, or only ſuch as is juſt neceſſary to cover them well.

The quantity of manures of this kind that will uſually be requiſite to be laid upon land under ſuch circumſtances, though it muſt vary conſiderably according to the ſtate of the ſoil, and the goodneſs of the dung, will, in general, be from about fifteen or ſixteen to twenty tons the ſtatute acre. Where, however, the main object of the farmer is that of bringing the land into a proper ſtate of cultivation, or that of affording a conſiderable degree of amelioration and improvement, it will often be neceſſary to have recourſe to much larger quantities if it be poſſible to procure them.

In turning down clover, or other new lays, where there is a conſiderable proportion of vegetable matter upon the ſurface, with the view of ſowing wheat or other crops upon them, it will ſeldom, perhaps, be requiſite to have recourſe to ſuch full dungings as may be proper under other circumſtances; but in all ſuch caſes the manures ſhould not be turned into them to too great a depth, as where that is done the immediate crop will often derive little or no benefit from ſuch dreſſings.

But in whatever method, and in whatever proportions, manure of the dung kinds may be employed, it ſhould always be ſpread out with as much evenneſs as poſſible, and be turned into the ſoil as ſoon afterwards as the work can be performed with facility. In conveniently accompliſhing theſe points, it will be neceſſary to depoſit it upon the land in ſmall heaps, and not to have too much carried out at a time; as by the firſt method the ſpreading may be effected with much greater exactneſs, and by the latter, the whole may be turned into the ſoil ſo quickly after its application as to prevent the waſte ariſing from evaporation, or the effects of rain, circumſtances of great conſequence where manures may be applied either in very dry or rainy ſeaſons.

But where ſubſtances of the calcareous kinds, ſuch as lime, chalk, marle, ſhelly matters, and even ſea or other ſorts of ſand, are to be made uſe of in the way of manures to tillage lands, as much of their beneficial effects evidently proceeds from their being very minutely blended with the particles of the ſoils, they may be applied with the greateſt chance of advantage where the lands are undergoing the culture of repeated ploughing, as in fallowing for wheat, turnips, &c. for in ſuch circumſtances their parts are in the greateſt ſtate of diviſion, or what by farmers is moſtly termed mellowneſs, and of courſe in the

moſt ſuitable condition for admitting the particles of ſuch materials to be the moſt evenly blended and incorporated with them. In this intention, theſe ſorts of materials ſhould always be ſet on in ſuch a manner, and be in ſuch fine ſtates of pulveriſation, as that they may be ſpread out upon the lands very equally. By chooſing a rather dry ſeaſon for the buſineſs, and depoſiting the ſubſtances in ſmall heaps along the ridges of the fields, ſuch work may, in general, be well and conveniently executed.

It is obvious, from what has been already advanced concerning the nature and operation of theſe ſorts of manures, that they muſt be uſed in different quantities or proportions, according to their qualities, and the differences in the ſoils *. It is, however, the common practice to apply a larger quantity to the heavy and ſtiff ſorts of land than to thoſe of the lighter kinds. Lime is uſed in different diſtricts at the rate of from one to four or five hundred buſhels, in proportion as the ſoils ſeem to ſtand in need of it. Chalk, in its calcined ſtate, is employed in the proportion of from one to two hundred buſhels, and in its crude ſtate to a much larger extent. Marle and ſea or other ſorts of ſand are laid on in various proportions from one to two thouſand buſhels, and in many caſes even conſiderably more †. When uſed on tillage lands, marle ſhould always be well broken down and reduced, as without this being duly attended to, but little benefit will often be produced.

Where lime, either from chalk or limeſtone, is made uſe of in repetition on the ſame land, it may frequently be more beneficial to employ it in the form of compoſt, with rich earths and other materials, than in its pure ſtate, as under ſuch circumſtances its effects in different caſes have been obſerved to be more beneficial. When made uſe of in ſuch a ſtate, the quantity laid on muſt, however, be conſiderably larger in proportion to the goodneſs of the ſubſtances that are blended with the lime.

In the applications of lime to the ſurface of coarſe ſorts of land, with the intention of breaking them up, and bringing them into the ſtate of tillage, much larger quantities than have been mentioned above may ſometimes be required, and which muſt be regulated by the nature and ſituation of ſuch lands, as has been already noticed.

Lime may alſo, ſometimes, be uſed on the wheat, turnip, or other crops, in the early ſpring months, eſpecially where danger from grubs, or other inſects, is apprehended. In ſuch caſes it is probably the beſt method to employ it in very fine powder, and in its cauſtic ſtate, ſowing it over the crops with as much

* See ſection on Manures. † Modern Agriculture, p. 204.

regularity as poſſible. This ſhould be performed when the weather is dry, as in a rainy ſeaſon injury might be done to the crops by the cauſtic properties of the lime. It may likewiſe be made uſe of in the ſame way, where no ſuch danger is feared, to promote the growth of the crop ; but in ſuch caſes it is probably better to apply it in the ſtate of compoſt with ſome earthy ſubſtance, and in a larger proportion than in the former inſtance. The quantity in all theſe caſes muſt be regulated by the circumſtances of the ſoil and the crops.

In applying materials of the dung kind, or ſuch as contain ſaline matters, as aſhes, ſoot, &c. in this manner, it will alſo be neceſſary to have them reduced into a ſtate of fine powder, in order that they may be ſpread over the crops with regularity and evenneſs. The effects of ſubſtances of this ſort will alſo greater if they are ſown over the crops when the weather is inclined to be wet.

The uſe of ſubſtances that have been much reduced and broken down, by being thinly ſown, and ſpread out over the land by the hand, is a practice that may be more generally had recourſe to in ſituations where manures are ſcarce and expenſive, as in this way the growth of crops may be promoted with but a comparatively ſmall quantity of them. They are, however, much leſs conſtant in their effects than ſuch as are turned into the ſoil, and of courſe can only be employed for the immediate crop. Where permanent advantage and improvement are to be given, the more maſſy ſorts of manure, either of the animal, vegetable, or foſſil kinds, muſt be applied according to the ſtate and circumſtances of the ſoils.

Various materials may be made uſe of in the manner of top-dreſſings for arable land, ſuch as rags reduced by cutting or chopping to very ſmall pieces ; rabbit, pigeon, and the dung of poultry in general ; ſoot, the aſhes of wood, turf, peat, and coal ; different animal matters, ſuch as horns, bones, hoofs, &c. after being brought to a coarſe powdery ſtate by grinding, or other means ; the combs and duſt of malt, and the refuſe of various ſorts of ſeeds, ſuch as flax and rape, &c.

The rags are applied in various proportions according to circumſtances, from half a ton to a ton and a half, or more, being ſown over the land immediately before the laſt ploughing, when they are lightly turned in, and the ſeed ſown ; their effects when uſed in this mode are often obſerved for ſeveral crops.

The dungs of rabbits, and different ſorts of birds, are moſtly employed for barley or turnip crops, in the proportion of about ſixteen or twenty ſacks to the acre, each ſack containing three buſhels, being thinly ſown over the land

after the laſt or ſeed-furrow has been given, and harrowed in with the ſeed. They are frequently alſo ſown on the young wheats and clovers in the ſpring, with great advantage; but when uſed in this way, they ſhould always be laid on very early, eſpecially on the drier ſorts of ſoil, as about the latter end of January; but on ſuch as are more wet, February, or even March, may be more proper. When their application is deferred to too late a period, there is often danger of their being leſs uſeful from the increaſing dryneſs of the ſeaſon, and their rendering the land, in ſome caſes, more apt to burn *.

Soot is chiefly laid upon the crops of wheat, ſaintfoin, and clover, that have had no previous manuring. It is uſually ſown over them with the hand, in the proportion of from twenty to thirty buſhels, or even more, to the acre, about January or February, having been collected into heaps during the winter for the purpoſe.

The vegetable aſhes, and thoſe of turf and peat, are likewiſe found uſeful to the young wheats and clovers, when ſown over them in the ſpring, in the ſame quantities as thoſe of ſoot; or a conſiderably leſs proportion of wood aſhes, as eight or ten buſhels, may be ſufficient. They may alſo be uſed on the turnip fallows with great benefit, being ſpread over them, and harrowed in with the ſeed. If ſown over the turnips in the early ſtages of their growth, wood aſhes are likewiſe ſaid to be beneficial in preſerving them from the ravages of the fly.

In Hertfordſhire, where theſe ſorts of dreſſings are, perhaps, more uſed than in any other diſtrict, the coal aſhes are principally employed on the clover crops, being bought from the different collectors of them in the county, or brought in back-carriage from London on taking the grain to the market during the winter ſeaſon, and ſown over them in the early ſpring. They are uſually laid on at the rate of about twenty or five-and-twenty ſacks of three buſhels each to the acre, and in this way are found of ſuch utility as to prove the practice highly economical, and deſerving of more general imitation by the agricultors of other diſtricts †.

When ſoot and ſubſtances of the ſame ſort are had recourſe to, they ſhould invariably be preſerved in places conſtructed for the purpoſe, and covered over ſo as to protect them from the rain and wetneſs, as where this practice is neglected, the ſaline matters contained in them being diſſolved, are carried down and loſt, by which means their valuable properties are conſiderably diminiſhed. The cuſtom of laying them in large heaps in the fields expoſed to the weather,

* Synopſis of Huſbandry, p. 42. † Ibid. 43.

however convenient, ſhould therefore always be avoided by the attentive agricultor, as waſteful in a high degree.

Where bones, horn, hoofs, and other hard animal materials are to be made uſe of in this way, they are commonly ſown over the land in the quantity of from about half a ton to that of a ton to the acre, according as they are reduced or broken down, before the laſt ploughing, and immediately turned in with a light furrow. If too large a proportion of this manure be employed, the grain, it is ſaid, becomes too luxuriant, and too long in ripening, as well as liable to injury from mildew. When made uſe of in the more lumpy or unreduced ſtate, they ſhould be turned into the ſoil a greater length of time before the ſeed is ſown, in order that time may be given for them to undergo decompoſition, and impart their nutritious properties to the earth.

The combs and duſt of malt are commonly made uſe of, as a hand-dreſſing to the young wheat crops, and thoſe of barley, turnip, and clover. They are employed at the rate of from thirty to forty buſhels, or more. They are frequently ſown with barley and turnip crops, in Hertfordſhire, at the rate of about thirty buſhels to the acre, and harrowed in. This manure, like many others of thoſe applied in the ſame way, is found to be the moſt beneficial where ſown over the crops at ſuch periods as that their effects may be promoted by the ſucceeding rains.

The refuſe of oily ſeeds, when laid upon heavy ſorts of land in the manner of a top-dreſſing, is frequently blended with a little lime, as about ſix parts to one; but upon light or calcareous ſoils it may be uſed alone. It is uſually ſown over the wheat crops, at the rate of eight or ten buſhels to the acre, and in ſome places diſperſed over the lands in the ſtate of preparation for wheat or turnips, and then lightly turned into the ſoil. This is ſometimes the practice in the county of Norfolk. The uſe, of cakes or the refuſe of this kind of ſeeds in the feeding of cattle, and other animals, has, however, of late, rendered it too expenſive to be much employed in the way of manure.

There are, probably, many other ſubſtances of ſimilar kinds to theſe that have been mentioned, that might be employed in this way, where there is a ſcarcity of other ſorts of manure, and in improving the ſickly and defective crops in the early ſpring months; but they have not yet been ſufficiently attended to by agricultors.

The expence of the application of manures in this way muſt obviouſly be very different according to ſituation and other circumſtances; but, in general, conſidering the great way they are made to go, and the readineſs and conve-

nience of their application, they may be ſaid to be cheap and economical *. By providing adequate ſupplies of theſe manures, it is aſſerted by the author of " Modern Agriculture," that the inconveniences of bad ſeed times and ſeaſons may, in a great meaſure, be obviated. And that as they are peculiarly adapted to the poor, light, ſandy, and gravelly kinds of ſoil, from which the ſpecifically heavieſt grain is produced, they may place them more on an equality in reſpect to their annual value, with thoſe of the ſtronger and richer ſorts. At all events, the increaſe in the practice of applying ſuch ſubſtances in thoſe diſtricts in which they have been long had recourſe to, ſufficiently, he thinks, juſtifies attempts of the ſame nature in others, eſpecially as ſuch kinds of materials may, in many ſituations, be procured with facility ‡.

In regard to the ſeaſon of applying manures to land in the ſtate of tillage, it muſt always depend in a great meaſure upon the convenience of the farmer, the ſtate of the ſoil, and the nature of the crops that are to be produced; but where theſe do not interfere, the diſſipating heats of the ſummer, and the waſhing effects of the winter and autumnal ſeaſons, ſhould as much as poſſible be avoided. For where they are laid upon the ground in the hot ſummer months, except they be immediately turned into the earth, a large proportion of their moſt beneficial properties muſt be forced off into the atmoſphere by the continued action of the heat, and be wholly loſt; and where they are applied in the more rainy periods of the winter, they muſt be liable to be diſſolved, and carried away into the ſurrounding ditches of the fields, or to ſuch a depth below the looſened mold, as to be of but little utility to the crops. The early ſpring, before the hot weather ſets in, and the latter end of ſummer, before the heavy rains begin to fall, and when the heat is becoming daily leſs, where the nature of the crops will admit, would probably be the moſt advan-

* It is ſtated by the author of The preſent State of Huſbandry in Great Britain, that the average price of top-dreſſings in Hertfordſhire, is as follows:

	£.	s.	d.
Thirty buſhels of ſoot, at 8d. is	1	0	0
Ditto of aſhes, the carriage being the principal expence,	0	10	0
Coal aſhes, ...	1	15	4†
Ten buſhels of oil-cake duſt, at 2s. 6d.	1	5	0
Forty buſhels of malt duſt, at 1s.	2	0	0
Fifteen buſhels of horn ſhavings, at 2s.	1	10	0§

† According to the author of the Synopſis of Huſbandry.

§ Editor of Miller's Dictionary.

‡ See Section on Manures.

tageous periods for their application, though the bufinefs is moft commonly performed by farmers during the more vacant periods of the drying fummer feafon, and of the winter frofts *.

There are ftill other means of improving arable lands, befides thofe of the direct application of thofe fubftances that are properly termed manures; fuch as thofe of turning into the foil various kinds of green vegetable crops in the moft fucculent ftages of their growth, the folding of fheep on land, and the covering of the ground by the overflowings of rivers, or the tides of the fea, &c.

Ploughing in green crops.—This is a method that has been employed in hufbandry for a very confiderable length of time on the Continent, though it is but little practifed by the farmers of this country. This, probably, arifes in fome meafure from the foils being in moft diftricts too wet and heavy for its being had recourfe to with much advantage; the light and more friable kinds of land being the moft adapted for improvement in this way, as in fuch defcriptions of ground the green materials undergo decompofition much more readily, and become more readily in the proper ftate for affording the nourifhment and fupport of crops. Indeed, in fome of the clayey foils, the putrefaction of fuch fubftances is retarded in fuch a manner, that little or no benefit can be derived from them.

In foils fuited to this method of manuring, crops of the green kind, fuch as buck-wheat, tares, clover, rape, and, where fown for the purpofe, peas or beans, &c. might be turned in as a preparation for wheat crops, without the expence of fallowing. Where this practice is employed, the crops, as has been juft obferved, fhould always be turned down when in their moft luxuriant ftages of growth, and the foil is rather dry, in order that a fpeedy decompofition and decay may take place. It is probable alfo, that advantages may be gained in this view by the application of fmall proportions of calcareous fubftances in their cauftic or more active ftate over them before they are turned down †. The economy of this practice muft chiefly depend upon the favings in cartage, and the labour of preparation, which in other forts of manure muft always be confiderable.

In fome diftricts ‡ this practice, after having been attempted, appears to have been given up from its not fully anfwering the purpofes for which it was

* See Section on Manures. † Ibid.

‡ Young's Agricultural Survey of Lincolnfhire, p. 265.

intended, which in all probability was owing to the lands, in moſt caſes, being either too wet or too heavy to permit a full and complete putrefaction of the vegetable matters turned down.

Folding of ſheep on tillage land.—This method of improving tillage lands ſeems to have been practiſed from the moſt early periods of the art of agriculture, and to be ſtill had recourſe to in different diſtricts of the kingdom with the moſt beneficial and advantageous conſequences. It however can only be employed with much ſucceſs where the nature of the farm admits of the ſheep-huſbandry being carried to ſome extent in combination with that of arable cultivation; and where the ſoil is of ſuch a dry, mellow, and light porous quality, as to require to be rendered more ſolid and compact by the treading of the animals. In ſuch as are much loaded with moiſture, or are very ſtiff and heavy, it will be improper and injurious. The treading, in the laſt ſorts of land, tending to render them more cloſe and compact, they of courſe become more improper for the growth of moſt ſorts of crops by the practice.

As it is probable that much of the beneficial conſequences of this method of huſbandry in tillage lands, muſt proceed from the action of the ammonia formed from the urine and excrement of the ſheep, it is eaſy to ſuppoſe that moſſy or peaty ſoils, as containing much vegetable matter on which it can operate, may likewiſe be greatly improved in this way, as well as by the conſolidation of the land from the treading of the animals. It is, indeed, impoſſible to ſuppoſe that the whole of the advantage that is obtained in many caſes of this ſort of ſoil, by the folding of ſheep, can be produced ſolely in the latter mode.

The practice of folding may be uſefully employed on ſuch ſoils as we have ſeen to be proper for it, in the ſummer ſeaſon, either as a preparation for wheat or turnip crops, in which caſes the ſoil ſhould not by any means be ſtirred to any great depth in the ploughings that may be given after the folds have been formed, as by turning in the ſurface-mold that has been rendered rich and mellow by the proceſs, to a conſiderable depth, the good effects of the practice muſt obviouſly be in a great meaſure loſt. In many inſtances it may perhaps be the beſt method merely to harrow in the ſeed without any further uſe of the plough; or what is probably a ſtill better practice, eſpecially on very light ſoils, is that of folding the ſheep upon the land immediately after it has been ſown. In hot ſeaſons, the turning it in by a ſlight furrow, as preventing any loſs by evaporation, may, however, be right. Folding may alſo be had recourſe to in the ſpring months, both as a preparation for the barley crop, and as affording vigour and ſupport to the young wheats, eſpecially where the ſoils are ſo light as to endanger the crops from the looſeneſs of the mold about the roots. In the laſt method the ſheep muſt be

fuffered to remain upon the land only a very fhort time each day, and be put in at fo early a period of the growth of the crops, that no injury can be produced by the pulling up of the plants in the feeding of the animals.

There is ftill another method of folding, which is fometimes made ufe of during the winter feafon, where the lands are fufficiently dry; this is that of confining the fheep upon fuch ftubbles as are intended to be ploughed up in the fpring. But in the firft methods the folds fhould not be nearly fo extenfive as in the laft; a flock of one hundred and fifty ewes and lambs being in the former modes confined on about four or five rods of ground, while in the latter they ought to have ten, fifteen, or even more *. The fpaces of land on which they are confined may, however, be much varied, according to the circumftances of the different cafes, and the purpofes the agricultor has in view, but they fhould always be fuch as that the animals may not be inconvenienced by being too greatly crowded together, and that the improvement of the land may be fully effected. Where they are not fo clofely confined, they may be fuffered to remain a greater length of time on the fame fpot, though in general it is by much the beft practice only to confine them one night on the fame fpace of ground.

From the nature of this mode of manuring land, it muft be obvious, as has been obferved, that it can only be employed with much fuccefs where there is a confiderable extent of common, grazing, or pafture land, annexed to the arable; or where green crops, fuch as turnips, tares, rape, and other plants of a fimilar kind, are cultivated upon a pretty large fcale. As where the fheep have not fuch defcriptions of land to feed and fill themfelves well upon, the evacuations voided by them can only be fuch as to afford a very flight improvement to the ground.

There are befides thefe fome other circumftances to be attended to in the management of this bufinefs on arable lands. The fheep fhould conftantly be kept as near as poffible to the lands that are intended to be improved by the fheep-fold, in order that no injury may be done to the animals, and that as little lofs as poffible may be fuftained during the time they are in driving from the paftures to the folds. In this view, fuch a number of folds will be neceffary as may allow the fheep not to travel further than would be fufficient for their feeding in other cafes, proper pafture or other lands being always provided for them as contiguous as may be to the grounds to be folded. In thefe it will alfo be an advantageous plan to keep them confined when the weather is wet and improper for their being driven and folded upon the ploughed

* Synopfis of Hufbandry.

lands *, as under fuch circumftances the lands are not only often much injured by the practice, but the animals greatly hurt.

The fheep, in all cafes of folding for the improvement of arable lands, fhould be fuffered to fill themfelves very well on the paftures or other grounds, before they are driven to, and inclofed in the folds on the ploughed lands. Hence it is probably the beft method to let them remain on the green food the whole or the greater part of the day, and only inclofe them in the folds during the nights, as in this way the greateft amelioration will not only be effected, but the leaft injury fuftained by the animals. In the mornings before they are turned out of the folds, it may be a beneficial cuftom to have them driven brifkly once or twice about the folds, in order to promote the evacuations of urine and dung. This may alfo, at the fame time, be ufeful in promoting the circulation, and benefiting the health of the animals.

The kinds of fheep that are the moft fuitable to be employed in this bufinefs, are thofe of the Devonfhire, or weft-country breed, as being the moft hardy, and bearing the confinement of the fold better than thofe of the larger and finer kinds; but many of the other forts may be made ufe of in the fame way, in diftricts where the above breeds are not kept, though a little more care may be required in the managing of them.

Warping.—This is a method of manuring and improving tillage lands, that can only be practifed in particular fituations, as in the vicinity of large rivers and waters into which the tides of the fea flow, and where the level of the grounds is fuch as readily to admit of their being overflowed by them. The aim of the agricultor in this mode of manuring land is, by admitting the floods or tides of fuch rivers to flow over and ftagnate upon the land, to obtain a confiderable fediment or depofition of muddy and flimy or other matter upon the furface of the ground, fo that a new foil may as it were be created. In order to this, the tide is let in at high water to depofit the warp or enriching fubftance, and fuffered to run off again as it falls. But to produce the full effect, it will be neceffary to have the water under fuch command that it may be kept out or let in as occafion may demand. This is accomplifhed in moft cafes by the cutting canals fo as to join the rivers, and fixing fluices at the heads of them, which may be regulated at pleafure, fo as to admit the water of the fpring-tides only, and others in proper places for difcharging or taking it off the land. And that the water may ftagnate upon the lands to a fufficient depth, and be prevented from overflowing the adjoining grounds,

* Anderfon's Effays, vol. III. p. 27.

banks are raifed all round the inclofures to be warped, of from three to fix or feven feet in height, according to the fituation and other circumftances of the land, having proper flopes on each fide. Where the land to be improved by this means is of confiderable extent, the main canal may be cut to a great length, fo as to warp the lands on each fide of it, by lateral cuts in fuitable directions to a confiderable diftance. But as the effects in thefe cafes are found to diminifh in proportion to the diftance from the river, a greater length of time will be neceffary for the depofition of the warp according to the diftance from it *. That it is not the water that produces the benefit in thefe cafes, but the depofition of mud, is evident from the bufinefs being difcontinued in the warping diftricts during frefh-water floods, as well as in the winter feafon. The refult of the analyfis of this muddy fediment, has fhewn it to confift of much mucilage, a very fmall portion of faline matter, with a large one of calcareous earth ; the refidue being mica and fand, each in a very minute ftate of divifion, and the latter in much the largeft proportion. It is alfo fuggefted, that though no mention is made of any argillaceous material, from examination of the warp on the fields, it is obvious, that it is prefent in fome cafes. The ftiffer forts of warp are alfo fuppofed by fome to be the beft †.

* The following directions for managing this bufinefs are given by Lord Hawke, in the Agricultural Survey of the Weft Riding of Yorkfhire:

" The land to be warped muft be banked round againft the river. The banks are made of the earth taken on the fpot from the land : they muft flope fix feet ; that is, three feet on each fide of their top or crown of the bank, for every foot perpendicular of rife : their top or crown is broader or narrower, according to the impetuofity of the tide, and the weight and quantity of water ; and it extends from two feet to twelve : their height is regulated by the height to which the fpring tides flow, fo as to exclude or let them in at pleafure. In thefe banks, there are more or fewer openings, according to the fize of the ground to be warped, and to the choice of the occupier, but in general they have only two fluices, one called the flood-gate to admit, the other called the *clough* to let off, the water gently ; thefe are enough for ten or fifteen acres : when the fpring-tide begins to ebb, the flood-gate is opened to admit the tide, the clough having been previoufly fhut by the weight of water brought up the river by the flow of the tide. As the tide ebbs down the river, the weight or preffure of water being taken from the outfide of the clough next the river, the tide water that has been previoufly admitted by the flood-gate opens the clough again, and difcharges itfelf flowly but completely through it. The cloughs are walled on each fide, and fo conftructed as to let the water run off, between the ebb of the tide admitted, and the flow of the next ; and to this point particular attention is paid. The flood gates are placed fo high as only to let in the fpring-tides when opened. They are placed above the level of the common tides.

" Willows are alfo occafionally planted on the front of the banks to break the force of the tides, and defend the banks by raifing the front of them with warp thus collected and accumulated ; but thefe willows muft never be planted on the banks, as they would deftroy the banks by giving the winds power to fhake them."

† Young's Survey of the County of Lincoln, p. 277.

As a ſort of new ſoil is created by this practice, it is of but little conſequence what the nature of the land may be, almoſt all kinds being improved by it. It will probably, however, be the moſt beneficial in ſuch light ſoils as are very open and porous, and ſuch ſtiff ones as are defective in calcareous matter, and which require ſubſtances of this kind to render them leſs tenacious. The beſt ſituation of land for performing this buſineſs in, is when it is in the ſtate of fallow; but it may be done when in that of ſtubble, or other ſimilar condition, and even in that of ſward, when the graſs begins to decline. The ſeaſon of doing it is generally in the ſummer months, from May or June till Auguſt, or September, as at theſe times the lands not only become the ſooneſt dry, a circumſtance which muſt always fully take place before the proceſs of cultivation can be carried on, but the tides are leſs mixed with freſh water, in which ſituation they are conſtantly found the moſt effectual. Land, when once well warped, will continue for a great length of time in good condition; but notwithſtanding this, it is ſuggeſted by ſome perſons converſant with the buſineſs, as a better practice to apply a ſmall portion of warp whenever the land is in the ſtate of fallow, which, under the arable ſyſtem, will be about every five or ſix years. By this means the farmer will be more ſecure of having good crops. The depth to which the lands are covered with the water muſt be various according to the differences of their levels, and the heights of the tides in the rivers from which they proceed. When it can be done, it may be admitted to the height of three or four feet or more, as the depoſit of ſediment is in ſome meaſure proportionate to the height of the water, though the ſame effects may be obtained from much ſmaller quantities of water, by continuing the proceſs a greater number of tides. Lands that have been ſubjected to this mode of improvement ſhould conſtantly be kept in the ſtate of tillage for ſome length of time afterwards, in order that it may be brought to a proper condition for the production of graſs †.

The expence of this method of improving lands will be very different in different caſes, as the circumſtances of ſituation and diſtance vary; but it can ſeldom exceed twelve or fifteen pounds the acre ‡, and in moſt inſtances it muſt be greatly below ſuch eſtimates, probably not more than a third of them ||.

† Brown's Agricultural Report of the Weſt Riding of Yorkſhire.

‡ Young's Survey of the County of Lincoln, p. 284.

|| It is remarked by Mr. Day, in the Agricultural Survey of the Weſt Riding of Yorkſhire, that no eſtimate can be made without viewing the ſituation of the lands to be warped, and the courſe and

Lands after having undergone this procefs are moftly capable of producing abundant crops of almoft any kind; but in general oats are the moft to be depended upon for the firft feafon; and they are faid to be more proper for the growth of this fort of crop, and thofe of wheat and beans, than barley, as the foil becomes fo rich in this way, that it fuffers in general by being too rank and coarfe. Flax may likewife be grown in many cafes to great advantage. They are alfo admirably adapted for potatoes, as well as various kinds of feed crops, and the being laid down for the purpofe of pafture *.

The practice of warping is adopted on the rivers Trent, Oufe, and Dun, with great benefit; and upon the low lands that are fituated near to large rivers, in other parts of the kingdom, the tide waters of which are often muddy, it may probably be had recourfe to with equal fuccefs.

Sowing.—In order to perform this bufinefs in the moft advantageous and perfect manner, it will be neceffary for the agricultor to pay particular attention to a variety of different circumftances, fuch as the quality, preparation, and quantity of feed that is to be put into the ground, the time and depth of fowing it, the ftate of the feafon, and climate in which it is to be fown; the nature of the land, and the particular kind of feeds or plants that are to be cultivated upon it, for on properly regulating and adapting his practice to thefe points,

diftance it will be neceffary to carry the warp to fuch lands, as, 1ft. The fituation of the lands muft be confidered. 2dly. The quantity of land the fame drains and cloughs will be fufficient to warp. 3dly. The expence of building the cloughs, cutting the drains, embanking the lands, &c. An eftimate of which expence being made, then it will be neceffary to know the number of acres fuch cloughs and drains will warp, before any eftimate per acre can be made; therefore it will be eafy to conceive the greater quantity of land, the fame cloughs and drains will warp, the eafier the expence will be per acre. In his opinion there are great quantities of land in the country, which might be warped at fo fmall an expence, as from £.4 to £.8 per acre, which is nothing in comparifon to the advantages which arife from it. He has known land which has been raifed in value by warping, from £.5 to upwards of £.40 and £.50 per acre; therefore it is eafy to conceive that the greateft advantages arife upon the worft land, and the more porous the foil the better, as the wet filters through, and it fooner becomes fit for ufe. The advantages of warping are very great; as, after lands have been properly warped, they are fo enriched thereby, that they will bring very large crops for feveral years afterwards, without any manure; and, when it is neceffary, the lands might be warped again, by opening the old drains, which would be done at a very trifling expence, and would bring crops in fucceffion for many years, with very little or no tillage at all, if the lands were kept free from quick grafs, and other weeds, which muft be the cafe in all lands where they are properly managed; befides the drains which are made for the purpofe of warping, are the beft drains that can be conftructed for draining the lands at the time they are not ufed for warping, which is another very great advantage in low lands.

* Agricultural Survey of the Weft Riding of Yorkfhire.

much of his fuccefs will probably depend. It will alfo be of much utility to have regard to the particular modes in which the feeds or plants are to be put into the foil, as fome variation will be required according as they are fown or put in by the broadcaft, drill, or dibbling methods.

It feems to be fhewn by the experiments and obfervations of an intelligent philofophical enquirer, that grain or feed during the act of vegetation draws oxygen from the atmofphere, part of which is retained, and the remainder thrown off charged with a portion of carbon. In this procefs the fubftances of the feed-lobes, therefore, undergo a confiderable change, an additional proportion of oxygen entering into their compofition, while a portion of their carbon is diffipated. By this alteration in the proportion of their conftituent principles, the faccharine fermentation takes place, and fugar is formed, as demonftrated in the operation of malting grain. The fugar and carbonic acid, from their being more foluble in water than the *oxyd* of the farinaceous matter, eafily, it is fuppofed, combine with the moifture in the capillary veffels of the feed, and find a ready paffage to the germ, the vegetative principle of which is thus brought into action by a *ftimulus* adapted to the particular nature of it. By the decompofition of the feed-lobes, a nutritious fluid being thus formed and diftributed through the infant plant, its organs are excited to exert their fpecific actions, in decompounding the nourifhment conveyed to them, and in forming new *oxyds* from the elementary principles of it, in order to the increafe and evolution of the veffels and fibres*. In this way, it is imagined, the firft ftage of vegetation commences; which, if the ingenious author's conclufions be well founded, would feem to fhew that the grain or feed, in order to its undergoing thefe different changes the moft readily, and in the moft perfect manner, on which, perhaps, healthy vegetation may depend, fhould not only be properly depofited in the foil, but be fo well ripened and filled with farinaceous matter, and poffefs fuch a degree of moifture, as may difpofe it to undergo fuch changes in a fpeedy manner, while at the fame time a due fupply of fuitable nutritious matter is afforded for the healthy germination, and early growth of the young plant.

In refpect to the choice of feed of the grain kinds, as frequently as poffible, it fhould, therefore, be a rule with the farmer to purchafe or referve fuch as is the moft full, plump, found, and healthy, of whatever defcription it may be, as it is only in this way probably that crops of good grain can be infured. And this practice is further enforced from the circumftance of its being in fome

* Gough on the Vegetation of Seeds, in the Memoirs of the Manchefter Society, vol. IV. p. 310.

meafure the fame with plants as with animals, that the produce is in a degree fimilar to that from which it originated.

But it is not merely on this principle that fuch grain as is fmall, fhrivelled up, and imperfectly fed, fhould be rejected as improper for feed; but as containing a fmaller proportion of farinaceous matter, and being thereby, as has been feen, lefs proper for affording that degree of nourifhment and fupport which is neceffary to the young plants during the period of germination, or the firft ftage of their growth. Where fuch feed as is fhrivelled up, and imperfectly ripened, is fown, in general but a little of it vegetates, and that which does, moftly fends forth plants of a weak and feeble kind, that afford only a lean and fteely fort of grain. Befides thefe, there are other circumftances which ought to be taken into the account in the choice of feed corn, fuch as that it be new and recently threfhed from the ftraw, and that the fkin be clear and thin; for it is found that grain which is frefh and only-juft threfhed out, is in a much more proper ftate for quick vegetation than fuch as has been long kept, confequently lefs liable to perifh in bad feafons; and that where the rind or fkin is of a bright colour, and thin, a much larger proportion of fine farinaceous or mealy matter is yielded from the fame quantity of grain, which renders it of courfe more valuable to the cultivator. This is particularly the cafe in wheat, and the fame thing probably takes place in refpect to other forts of grain. The experiments of a late writer feem indeed to fhew, that wheat, after being kept fix or feven years, though there may not be any perceptible difference in its appearance from fuch as is new, is wholly unfit for being made ufe of as feed, on account of only a fmall portion of it being capable of vegetating*. This may, probably, in many cafes be owing to the grain being more difpofed under fuch circumftances to take on the putrefactive fermentation, or become rotten, than to the abforption of oxygen, which is believed to be effential to the procefs of vegetation, in the early ftage†. It is probable, too, that befides this effect where the moifture and juice of the grain is much taken away, as is the cafe in keeping it for a confiderable length of time, the plants that are produced from it may even be lefs vigorous and luxuriant, as happens in gardening to fome kinds of feed, as that of the mellon, which is frequently kept for feveral years, in order to effect this purpofe the more fully.

On the principles which have been ftated above, it is therefore obvious, that in

* Synopfis of Hufbandry, p. 80.

† Gough on the Vegetation of Seeds in Manchefter Tranfactions, vol IV. p. 310 & 488.

order to fecure the moft perfect vegetation of grain, it fhould not be placed too much out of the influence of the atmofpheric air, and that the bed of earth in which it is depofited be in as fine a ftate of pulverifation as poffible, as under fuch circumftances the air is more uniformly admitted, and the feed, from being in a more equal temperature, and more equably fupplied with moifture, is expofed in the moft favourable manner to the combined effects of the caufes that have been found to promote the germination, growth, and profperity of the young plant *.

As to fuch grain as is in any way difeafed, it fhould never be made ufe of as feed. The experiments of the author of the Synopfis of Hufbandry clearly prove, that no method of preparation that has been yet attempted has been fufficient to render it capable of producing healthy plants. In his different trials he invariably found, that in wheat which was affected with the *fmut*, the grains univerfally produced a fucceffion of ears that were tinged in a greater or lefs degree with the diftemper, and that neither fteeping nor the change of foil made any difference in preventing it, but that that which had been fteeped and limed, as well as that which was fown dry, afforded difeafed ears. The fowing of this fort of feed, though it may have been advifed by fome incautious agriculturs who have placed too much confidence on the efficacy of *fteeps*, can only difappoint the expectations of the farmer in propagating more widely the ravages of fuch vegetable difeafes, and producing fcanty fupplies of found grain.

There is ftill another point that ought not to be overlooked in regard to feed corn, which is that it be clean and perfectly free from the feeds of every fort of weed, as where this is not fufficiently attended to, crops may be greatly injured, if not wholly fpoiled, by the growth of weeds, and fuch noxious plants introduced into the foil as cannot be removed again without confiderable trouble and expence.

There are different methods that may be purfued in order to fecure fuch grain as is healthy, and proper for the purpofe of feed. The beft is probably that of felecting from amongft the corn while it is growing in the fields, as in this way an opportunity is afforded of choofing fuch heads or ears of the plants of different kinds, as are the moft perfect, the moft forward and vigorous in their growth, and which contain feed that is the moft plump and full, and the beft ripened. Thefe advantages may likewife, in fome refpects, be attained in the more valuable forts of grain, by having them picked over by the hand after

* Gough on the Vegetation of Seeds, in the Manchefter Tranfactions, p. 324.

being threſhed out ; but the practice is tedious, and not ſo certain of having the ſeed from the moſt healthy and beſt ripened plants.

In order to be poſſeſſed of the beſt and moſt perfect ſorts of ſeed, the moſt healthy and vigorous plants ſhould therefore be choſen, and ſuch as are the moſt early in reſpect to the ſeaſon, and theſe while growing be ſo preſerved that they may not be injured by having weaker plants of the ſame kinds near them ; as the art of having good ſeeds does not, it is aſſerted by an experienced agriculturor, depend upon obtaining new ſeeds from ſituations at a conſiderable diſtance ; but upon collecting and preſerving the beſt ſeeds or roots of our own production. This method of practice has been adopted in conſequence of having remarked that, though vegetables of every kind are extremely liable to undergo changes in regard to the periods of their becoming ripe and other properties, the beſt ſeeds never fail to afford the beſt plants *.

In preſerving ſeed grain, by collecting it in the ears from the ſtack, there may however, it is obſerved, be diſadvantages, both in the way of leſſening the produce by chooſing the largeſt ears which have ſeldom more than one upon a ſtem, and by taking ſuch as become ripe at different periods †.

There are various methods of aſcertaining the goodneſs of grain or ſeeds, but the farmer chiefly depends upon the appearances that they exhibit, preferring ſuch as are full, plump, well fed, and that have a certain brightneſs and clearneſs, without any ſhriveling or ſhrinking in the covering or ſkin.

The ſame purpoſe may, however, be accompliſhed with greater accuracy by other means, as the weighing of a certain meaſure ; it being well known that grain or ſeeds, on being immerſed in fluids, have the more light and imperfect floating on the ſurface, while the better and more perfect ſink to the bottom. On this principle, ſolutions well ſaturated with ſaline ſubſtances, from their gravity being much increaſed, become excellent for aſcertaining the goodneſs of grains; as none but ſuch as are perfectly ſound will ſink in them.

It is obſerved by the author of Phytologia, that the weight of a given meaſure of grain may alſo be a tolerably certain method of diſcovering the quantity of huſk or bran contained in it, compared to the quantity of flour ; as that grain which is cut too early, or which is otherwiſe not quite ripe, as happens in wet ſeaſons, ſhrinks in the barn or granary, and becomes wrinkled, and has thus a greater proportion of ſkin or bran than that which has been more perfectly ripened, and will hence weigh lighter in proportion.

* Prieſtley in Communications to the Board of Agriculture, vol. I. † Ibid.

Another method that may be had recourfe to in order to diftinguifh light from heavy grain, is that of winnowing, as the furfaces of light grains, from their being greater in proportion to their folid contents, will be carried further by the current of air afforded in the operation; yet in paffing them through a fcreen the heavy grains may be liable to run further out on the floor from their being more propelled by their greater gravity, without the refiftance of the air on their furfaces being increafed *.

And as grain that has undergone fermentation, or been heated much, or burnt in the ftack, as it is moftly termed by farmers, is improper for feed, from its not being capable of vegetating, it may be of utility in many cafes to be able to difcover where this has happened. The following method, which is perfectly fimple, has been recommended for the purpofe. A pafte is to be made with water from the flour of the fufpected grain, which is then to be wafhed by the hand under water, which is frequently changed, until no difcolouration of it takes place. The fubftance which is left in the hand is the glutinous part of the grain, and which, if the corn be good, is elaftic, contracting readily on being drawn out; if it has only been juft heated, it is brittle; but where it has fermented, none of the gluten will be afforded †.

Much has been advanced by fome agricultors on the importance of changing of feed of the fame kind, probably from adopting imperfect notions of the nature of vegetation, or purfuing falfe analogies in refpect to the breeding of animals, but it is evident from the trials that have been made in the cultivation of grain, and from what happens in particular cafes of gardening, that it will be of no utility to have recourfe to the change of feed, provided it is properly adapted to the foil, except it be for an improved kind. The only thing neceffary is that of collecting and preferving the beft of the different kinds, in the methods that have been directed above, and by that means prevents a degeneracy. It is hardly to be fuppofed that the foil can become tired of, or be improper for, producing a fort of grain for which it is adapted, fince it may be obferved that the fame forts of plants are frequently propagated on the fame fpots of ground for a vaft length of time without any manifeft injury in refpect to their quality.

As fome of the varieties of the fame fort of grain or feed, when fown under fimilar circumftances of foil and climate, are however often found by the cultivators of land to be of a much more early growth than others, as well as of

* Darwin's Phytologia, p. 455. † Mon. B. G. Sage, in Journal de Phyfique, 1794.

a more or lefs hardy and vigorous nature, it may be of utility to change them in thefe refpects, the early kinds being always cultivated on the colder and more backward defcriptions of land, while thofe of the later are fown upon the drier and more warm foils. In this way the crops may often be confiderably improved, as, in fo far as regards themfelves, they will enjoy the advantages of more genial foils and climates. Another advantage may be gained in this method, as by employing fuch early kinds of feed the farmer may, in fome cafes, delay the putting in of his feed for feveral days, without the danger of the crop being injured thereby, or of its not being reaped at the ufual time. He may likewife in the late foils thus obviate the difficulties and inconveniences attending bad feed times, as by fuch a change the feed, though put in later, may be equally early at the harveft *.

It has alfo been remarked, that there is an advantage refulting from changing feed from foils of oppofite natures, which cannot be depended upon when the change is made from fimilar foils. Some weeds will grow only in ftrong deep lands, while others are peculiar to light and fandy foils. When, from whatever caufe, grain abounds fo much with the feeds of weeds as to render it improper for fowing, by procuring feed from a foil of an oppofite nature the farmer is to a great degree certain that no dangerous feed-weeds will be introduced by the change †. The fowing of fuch grain as contains the feeds of weeds fhould, however, never be practifed, except where perfectly clean feed cannot be procured, as, though the above may be the cafe in regard to particular forts of weeds, it does not by any means extend to all.

It is found that grain, like all other feeds and plants, when brought from a warmer to a colder climate, gradually degenerates till, by being frequently cultivated, it becomes natural both to the foil and climate. And experience has fhewn that it degenerates fooner, and to a greater degree, in mountainous diftricts, than in the level and better fheltered parts of the country. At the fame time, it is well known, that many vegetables introduced from other countries, and which it was once thought would not come to maturity in this, have, by proper care and attention, been brought to a great degree of perfection. It is certain, too, that the introduction of better forts of grain has foon become effectual in removing the poor kinds that were originally cultivated. This has been the cafe in refpect to oats in fome parts of Scotland: which is a circumftance that, the writer juft mentioned thinks, proves how much the quality of

* Donaldfon's Modern Agriculture, vol. II. p. 261. † Ibid.

grain may be improved by proper attention; and further, that frequent and judicious changes of feed, in the way ftated above, are of the greateft importance in effecting this improvement.

And it is concluded, that from the long-eftablifhed practice, and the acknowledged advantages derived from annually importing feed-wheat from England into all the diftricts in Scotland, where that fpecies of grain is cultivated, which are well known; as well as from the practice being no lefs general, although more local, for the farmers in Banff-fhire, where deep ftrong cold foils prevail, to procure, in unfavourable feafons, a great portion of the oats neceffary for feed from the light dry fandy foils in the adjoining county of Moray; and alfo the practice of many other diftricts where improved agriculture is to any confiderable degree eftablifhed; it will be found that frequent changes of feed, for fome or other of the reafons mentioned above, are not only highly proper but indifpenfably neceffary *.

On the whole it is maintained by an ingenious writer, that as the varieties of plants are fuppofed to be produced by different foils and climates, which varieties will afterwards continue through many generations, even when the plants are removed to other foils and climates, it muft be advantageous for the agricultor to infpect other crops, as well as his own; and thus wherever he can find a fuperior vegetation, to collect feeds from it; which is, it is imagined, more certain to improve his crops than an indifcriminate change of feed. And that where feed-corn is purchafed without a previous obfervation of its fuperior excellence, perhaps it would be more advantageous to take it from better kinds of foil, and from fomewhat better climates; as the good habits acquired by fuch feeds may be continued long after their removal to inferior fituations. But, on the contrary, care fhould be taken not to collect a change of feeds from worfe climates or inferior foils, unlefs the agricultor is previoufly certain that they are of a fuperior kind †.

Though the practice of preparing feed of particular kinds for being put into the earth, by fome means or other, feems to have prevailed, in fome degree, fince the earlieft periods of the art of hufbandry, the utility or advantage of the procefs does not appear to be yet fully afcertained by agricultors; fome contending that it is highly beneficial, while others maintain that no poffible benefit can be derived from it. It can, however, hardly be conceived, that a practice of this fort fhould have been employed for fuch a vaft length of time, without fome

* Donaldfon's Modern Agriculture, vol. II. p. 263. † Darwin's Phytologia, p. 452.

beneficial confequences had been obferved to refult from it. The nature of the vegetation of feeds, and the circumftances under which it takes place in the moft favourable manner, would alfo feem to fhew that it may be had recourfe to with benefit in more cafes than it appears to have been cuftomary to employ it by the farmer.

Various compofitions have been employed at different times for the purpofe of preparing grain which is to be made ufe of as feed. In the more early attempts in this way, oils, and the decoctions or juices of particular plants, were chiefly employed, and the moft fully relied upon; but the liquors which have lately been the moft depended upon, are either water fo highly impregnated with common falt that an egg will fwim upon the furface of it, or fuch chamber-lye as has been kept for a length of time fufficient for its undergoing decompofition, and the forming of ammonia. And whichever of thefe liquids is made ufe of, the feed, after being fteeped for a proper length of time, is rendered dry and fit for fowing, by cauftic or quick lime, in a fine ftate of pulverifation, being intimately blended with it.

By modern agricultors, fteeps or pickles of thefe kinds appear to have been principally made ufe of for preparing wheat, in order to prevent it from being affected with difeafe; but it is probable that they may be applied to moft other kinds of feed, and in very different views, with ftill greater and more beneficial effects. As it would feem neceffary that the feed-lobes of grain, which have been found to confift of a vegetable *oxyd* or bafis, compounded of carbon and hydrogen, impregnated with oxygen, a portion of oil, or of the bafis of it in an unoxydated ftate being diffufed through their compofition *, fhould be imbued with a certain proportion of humidity or moifture, in order that fuch changes may take place in them as are fuited to the procefs of vegetation; the fteeping of feed may, in this way, not only fecure a more fpeedy and regular germination, but in fome cafes obviate the danger of its being injured or deftroyed by the length of time it may be neceffary for it to remain in the foil before it becomes fufficiently moiftened. And as it is probable that different kinds of feed abforb or take up different proportions of moifture in the fame time, this circumftance fhould be attended to in the practice, and fuch forts as are found to charge themfelves flowly, expofed in the fteeps for a greater length of time †.

In proof of the utility of fteeping in this view, it has indeed been obferved,

* Gough, in Memoirs of the Manchefter Society.

† Ibid.

by an experienced agricultor, that there can be no doubt that, in every particularly dry feed time, feed of every kind ought to be fteeped juft enough to promote a quick vegetation. This method would, it is thought, at all times prevent great deftruction by vermin, fecure a more uniform growth, and greatly improve both the quantity and quality of barley and oats; and fometimes, indeed, procure a crop of clover, which would, without fuch precaution, have been loft *. And others fuggeft that by foaking feeds a day or two previous to their being put into the foil, their growth may be promoted equally as well as by watering the land by artificial means, either immediately before or after their being fown †. But befides thefe, the fteeping of feed-grain may be ufeful in other refpects; as, where attention is paid to having the liquors as much as poffible faturated with faline matters, it may, as has been feen, enable the farmer to readily feparate the faulty imperfect feed that is incapable of vegetating, from that which is good and proper for the purpofe, as the light imperfect feeds conftantly float upon the furface of fuch liquids, and may be eafily removed, while thofe which are found and good fall to the bottom, and by being employed as feed may infure more regular, perfect, and uniform crops.

And where liquids or fubftances of a poifonous or deftructive quality, fuch as the folutions of noxious plants, cauftic lime, &c. are had recourfe to, they may be of utility both by rendering it lefs the prey of vermin, and deftroying fuch as attack it. The latter may likewife be of advantage by its properties of attracting the humidity and moifture of the furrounding air and foil, as well as by deftroying fuch infects as come in contact with it ‡.

It may, in fome inftances, alfo be of advantage to make ufe of fuch liquid materials as have been found ufeful in promoting the growth of plants, fuch as the carbonated liquor afforded by dung-hills, and many fimilar matters. It has been found, that by fteeping feed-barley for twenty-four hours in a fluid of this fort, removing the light grains that came to the top, and, on taking the grain out of the fteep, fifting wood-afhes over it in order that it might be fown with regularity, a much better crop was produced than from the fame grain fown without undergoing any preparation ‖. In China, the ufe of fuch fluids for the fteeping of feed is likewife fuppofed to be equally beneficial in promoting the growth of the crop, and preventing it from being deftroyed by infects §.

Others, however, affert that folutions made with various fubftances, which

* Middleton's Survey of Middlefex, p. 141. † Darwin's Phytologia, p. 464. ‡ Ibid.

‖ Chappel, in Memoirs of Bath Society. § Staunton's Embaffy to China.

are ſuppoſed to have a tendency to promote the vegetation of ſeeds, have been employed without their producing any beneficial effects *. But as little ſeems to have been done in the way of experiment with a view to aſcertain this point, and as it is well known that both moiſture and the recrements of vegetable and animal matters are highly uſeful in aiding the growth of the plants in their more advanced ſtages, it may be concluded that they may have advantageous effects when applied to, and taken up by, the ſeed in the liquid ſtate, though it is obvious that their power in this way muſt be conſiderably limited, not only from the ſmallneſs of the quantity imbibed, but from the ſeed containing the proper materials of its early nouriſhment within itſelf.

In regard to the effects of ſuch preparations in the prevention or removal of the diſeaſed conditions of ſeed, there are different opinions entertained by agricultors; ſome contending that they are wholly ineffectual, while others maintain that they have derived the moſt evident advantages from them. Satisfactory experiments have, however, yet gone but a little way in determining the matter. The few trials that have been made by the author of the Synopſis of Huſbandry, with reſpect to ſmutty grain, ſeem to ſhew that they cannot be much depended upon in this view, though they do not throw much light on the nature of the diſeaſe. A writer of much experience and acuteneſs of obſervation is, notwithſtanding, decided in his opinion of their utility, having wholly prevented the diſeaſe by making uſe of them †. In his attempts he appears, however, to reſt much of the effect upon the lime employed being newly burned and ſlaked in boiling water, and the ſteep or mixture being then poured *boiling-hot* over the grain previouſly ſpread out on a ſtone floor, afterwards blending it well by frequent turning. The heat of the water, ſays he, aided by the ſuffocating ſmell of the fixed air diſcharged from the lime, ſeems to be ſufficient to deſtroy the animalculæ to which ſome aſcribe the ſmut, and alſo to coat the wheat ſo as to become a preſervative from vermin. And the able author of the Agricultural Survey of Staffordſhire aſſures us, that the propriety of the practice, and its good effects in the preventing of the ſmut, are eſtabliſhed by the moſt weighty of all arguments, experimental proof; and further that he has never known or heard of a well-authenticated inſtance of its failure in preventing the diſeaſe. Experiment has not, however, fully demonſtrated that this vegetable diſeaſe proceeds from animalculæ, or that carbonic acid gas is effectual in deſtroying them. It is more probable that the heat thrown out dur-

* New Farmer's Calendar, p. 417.

† Middleton's Survey of the County of Middleſex.

ing the combination of the water with the lime, together with the cauftic properties of the latter might produce fuch effects. However this may be, the utility of the practice is rendered ftill more probable by the author of Modern Agriculture giving it as the refult of the experience of agricultors in general, that where it is followed fmut is feldom or never feen in the fucceeding crop *.

When fteeps of this nature are, however, employed in this view, it would feem that the feed fhould lie much longer in them than when the intention is merely that of feparating the imperfect from the good and found feed†.

The manner of performing the bufinefs of fteeping is different in different places; but the moft common way is that of forming the brine, in the mode that has been mentioned, in a large tub or other convenient veffel, and then fimply putting in the grain and permitting it to remain for ten or fifteen hours, removing the light grains as they come to the furface, after ftirring it at different intervals. But another, and much more expeditious and convenient method, is that of placing the feed in a bafket, and letting it down into the veffel containing the fteep, fkimming off the light corn occafionally, and after it has remained a proper length of time, according to the views of the agricultor, removing its contents, and replacing them by other parcels.

In whichever way the procefs of the fteeping is performed, no larger a quantity is to be prepared at a time than is capable of being put into the ground the fucceeding day, as where the grain is fuffered to remain in the fteep for any great length of time, much of it is found to be incapable of vegetating ‡. In further proof of this, the writer of the Agricultural Survey of Mid-Lothian fays, that about four years ago, having fteeped a firlot of barley in urine for about three hours, and immediately thereafter caufed it to be fown at the ufual rate, in the middle of a field, unmixed with any other, there was not above a half of it came up, and even that grew fo weakly as not to produce above a third part of the crop with the reft of the field. An able experimenter has, however, fhewn that greater latitude may be taken in this refpect than is commonly fuppofed ||. And Mr. Middleton has known feed prepared a week before it was fown, without fuftaining any injury. As the experiments of Mr. Gough have, notwithftanding, fhewn that the procefs of germination prefently commences after feeds have been

* Vol. II. p. 281. † Curfory Obfervations on Hufbandry, p. 63.

‡ Donaldfon's Prefent State of Hufbandry, p. 281. || Gough, in Memoirs of Manchefter Society.

imbued with a ſuitable proportion of humidity, it would ſeem to be the moſt proper practice not to delay the ſowing much after the ſeed has been prepared.

In regulating the proportion of ſeed that may be neceſſary to be ſown, attention will not only be requiſite to the peculiar nature, quality, and ſituation of the ſoil, and the periods of ſowing or putting crops into the ground, but alſo to the ſtate of the ſeaſon, and the manner in which the ſowing is performed.

In general, for moſt ſorts of crops, the ſtrong, wet, and ſtiffer deſcriptions of land will require larger proportions of ſeed than ſuch as are more friable, thin, and light. Hence the ſtrong wet loams, and the ſtiff retentive clays, demand more ſeed than the light mellow loams, and the ſandy, gravelly, or even the thin chalky ſoils. As where lands of the rich loamy kinds have been ſuitably broken down, and reduced by the various operations of tillage already deſcribed, if the ſeed be not ſown in too large a proportion, an opportunity is afforded for the plants tillering, or ſpreading themſelves from the roots, many ſtems often iſſuing from the ſame root: in conſequence of which, the crops frequently become, even when thinly ſown, extremely thick upon the ground; and from the great nutritive powers of ſuch ſoils, or what is moſtly termed ſtrength by farmers, would be greatly too much ſo, if a large proportion of ſeed were at firſt put in.

And, indeed, in the caſe of root crops, whether ſuch as are formed upon or within the ſoil where ſuch lands are in a ſufficiently mellow and friable ſtate for producing them, the ſeeds or ſets ſhould not on the ſame account be ſown or put in in too great a quantity or too thickly.

But in the ſtrong, ſtiff, wet, retentive, ſoils, from the plants ſeldom ſtriking or branching off much from the roots, except in particularly favourable circumſtances of ſeaſon, a much greater proportion of ſeed will be neceſſary, in order to ſecure ſuch full crops as lands of this kind are capable of ſupporting.

On the light thin ſoils a leſs quantity will be ſufficient, as if a large proportion of ſeed be put into ſuch kinds of ground, from their poſſeſſing but little ſtrength in compariſon with the former, the crops will rarely, except in particular ſeaſons, be well formed in the ear, or have the grain plump and well fed *. It is likewiſe a practice in the beſt grain diſtricts, on all deſcriptions of ſoils, to ſow ſmaller proportions of ſeed on lands of the ſame quality in the early periods of the ſeed time, than thoſe of the later. The reaſon of this, ac-

* Donaldſon's Preſent State of Huſbandry, p. 265.

cording to the author of the work juſt quoted, is, that grain ſown early in the ſeaſon takes deeper root, and has more time to branch out additional ſhoots, than that which is late ſown, which, when the ſoil is not very free, as well as fertile, generally runs up into one ſingle ſtalk, ſo that if a liberal quantity of ſeed be not allowed, the crop, however luxuriant in reſpect to the plants, muſt be ſcanty in the article of grain.

There may alſo be other reaſons; as where the ſeed is put in at a late period, eſpecially in the ſpring ſowings, it will not have time fully to eſtabliſh itſelf in the ſoil before it becomes retarded by the hot and dry ſummer weather, unleſs a large quantity of ſeed be employed ſo as to afford protection by the cloſeneſs of the growth of the plants. And in the late autumnal ſowings, the grain may not become well fixed and rooted in the ſoil before the froſts begin to affect them, and on that account a larger proportion of ſeed be required.

The ſtate of the weather may likewiſe have conſiderable influence in reſpect to the ſowing or putting ſeed into the ground, as where the ſeaſon is very dry, and there is but a ſmall proportion of moiſture in the ſoil, more of the ſeed may fail in vegetating than where the contrary is the caſe. Hence the propriety of the practice of ſteeping and putting in the ſeed in ſuch dry ſeaſon immediately after the plough.

The manner in which the ſeed is depoſited in the earth muſt alſo produce conſiderable difference in regard to the quantity of ſeed, as where the grain is ſcattered over the whole of the land in ſome meaſure at random, as happens in the common broadcaſt method of ſowing, a much larger proportion of ſeed muſt be required, even with the moſt expert ſeedſman, than where the grains are depoſited with equality and exactneſs but only on certain portions of the land, as is the caſe in the drill and dibbling methods. Beſides, ſome diſadvantages may attend the firſt method in reſpect to the vegetation of the ſeed, that may likewiſe render a larger proportion requiſite.

From what has been advanced it muſt be evident that the quantity of ſeed muſt vary according to a great variety of circumſtances, and that it is a matter of much difficulty to fix upon any proportion that may be ſuitable to every circumſtance and deſcription of ſoil. From two and a half to three and a half buſhels to the acre may, however, in general, be conſidered as the proportion that will be the moſt frequently requiſite, both for the ſpring and autumn ſowings. It has been ſuggeſted by an experienced cultivator, that for ſowing wheat broadcaſt about the latter end of September, two buſhels and a half is the moſt advantageous quantity on ſoils of a medium quality; and that for every

fortnight later a gallon of ſeed ſhould be added *. Nothing can, however, be ſaid with much exactneſs on the ſubject, ſince the advantage of different proportions have not yet been fully ſhewn †.

* Middleton's Survey of Middleſex.

† Mr. Arthur Young, in his able Survey of the County of Lincoln, has given a tabular view of the quantity of ſeed and produce, which may be uſeful in ſhewing the effects of different proportions of ſeed on different kinds of land.

Kinds of Soil.	Places.	Wheat.		Barley.		Oats.		Beans.	
		Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.
Rich new broken up common land.	Long Sutton -	—	5	—	—	—	10½		
	Deeping Fen -	—	—	—	—	—	9		
	Holland Fen -	2½	4	—	—	6	7		
	Mr. Cartwright -	—	4½	—	—	—	8	—	4½
	Folkingham - -	3	3½	3	5	5	6	4	3½
	Belton - -	3	2½	4	4½	7	5		
	Ditto Heath -	—	—	—	3	—	4		
Middling land.	Leadenham - -	3	—	4½	4				
	Hackthorne - -	3	3	4	3½	5	4		
	Norton - -	3	2¾	3	4				
	Knaith - -	2½	3	4	5				
New incloſed land.	Haxey - -	2¼	3	4	4	4	5	3½	4
	Butterwick -	—	5	—	—	—	—	—	4
	Normanby - -	2½	3	4	4	—	—	4	3
	Winterton - -	—	4						
New incloſed land.	Barton - -	3½	4	4	4½	—	—	3	4½
	Mr. Graburn - -	4	—	—	—	7	—	4	5
	Mr. Scrivenor -	—	—	—	—	—	10		
	Barrow - - -	3	3						
	Wintringham -	3	5	4	6	—	7	—	5
Wold land.	Brockleſby - -	3¾	2½	4	4	7	5	3	3
	Beleſby - - -	—	—	4	5	—	—	4½	3
	Humberſton - -	2½	3	4	3	7½	4	4½	3½
	Saltfleet - -	—	—	—	—	—	10		
Marſh land.	Louth - - -	3	—	5	—	7	—	5	
	Dalby - - -	3½	3	5	4	8	5½		
	Spilſbury, Mr. Wright	3½	4	4	5½	5½	7½		
	Welton - - -	—	3½	—	—	—	—	—	3
	Ditto - - -	—	2½						
Clay and marſh land.	Skirbeck - -	2½	3¼	—	—	5	7½	4	3½
	Reeveſby - -	3½	2½	4	3¾	5	5		
	Mr. Parkinſon -	2	3	2	4½	4	8		
	Ranby - -	3	3	4	3½	6			
	Ditto - - -	—	—	—	2½	—	4		
	Mr. Elmhurſt -	4	5	4	6				
	Swinop - - -	3½	3	4	4½	6	5		
	Mr. Elliſon - -	2½	3	4	4	6	5		
Strong land.	Claypool - - -	3	3¾	3¾	4¾	—	—	2	4¾
	Woolſthorpe - -	2½	3½	3	4½	6	6		
	Grimſthorpe - -	2¼	3¼	3	4½	6	5	2¾	4
	Average -	3	3½	3¾	4¼	6	6½	3¾	3¾

But though the proportions of feed that may be the moft proper and advantageous for affording the fulleft and moft abundant crops in different cafes, and under different circumftances, have not yet been decided by the aid of experimental inveftigation, the only method that appears capable of affording any degree of certainty on the fubject; there is ftill another point that fhould never be overlooked by the correct agricultor, which is that in fowing feed that is known to be good and perfect in its quality, a lefs quantity will always be fufficient than where the contrary is the cafe, as in the former inftance almoft every feed will vegetate, while in the latter, many muft prove faulty.

The time of fowing, or putting crops into the ground, is evidently a matter that muft depend in a great meafure upon their economy and the peculiarity of their nature. Hence the moft proper and advantageous feafon for fowing or fetting fuch as poffefs the habit or are capable of perfecting and ripening their feed or produce in the fame year, is that of fome of the more early fpring months, according as they are more forward or late in their kinds, and the clime more mild, or the contrary; while in fuch as are, from the peculiarity of their nature or habits, incapable of completing their vegetation in the fame year, the moft favourable period will be fome of the more early autumnal months, according to the differences of their habits, and the variations of climate and feafon; as by thefe means in the former cafe the feeds, grains, or roots, become perfectly evolved, and the radicles of the young plants firmly eftablifhed in the foil, and capable of fuftaining themfelves againft the hot feafon fets in which is to bring them to maturity; and in the latter the feeds have attained fuch a ftate of growth, and fo far fixed their roots in the ground, as to be capable of fupporting themfelves without fuftaining much injury from the feverity of the winter feafon, and confequently advance with greater rapidity in their vegetation in the fpring, in order to perfect their feed by the heat of the fummer feafon.

It has, however, by fome cultivators been particularly advifed to adopt the practice of fowing certain forts of grains and feeds, and alfo of fetting particular kinds of roots, at much earlier periods in the fpring than is commonly had recourfe to by the farmer. Thus by putting barley into the ground in the beginning of February, great advantage has been fuppofed to have been derived in the forwardnefs and finenefs of the grain *.

Againft this method it is, however, ingenioufly fuggefted, that as much

* Lord Orford in Young's Annals of Agriculture, vol. IX. p. 389.

moiſture, with or without ſubſequent froſt, is more liable to deſtroy the embryo in its very early ſtate in the ſeed than after it has ſhot out roots and a ſummit, and thus acquired ſome habits of life, ſuch early ſowing muſt in ſome caſes be practiſed with caution *. Such an objection cannot, however, be brought againſt the early autumnal ſowings. The ſame philoſophical writer alſo remarks, that the difficulty of determining the beſt ſeaſon for ſowing ſeeds in the ſpring, owing to the variation of the weather in the ſame latitude, as well as of laying down the exact ſeaſons for ſowing in different latitudes, occaſioned Linnæus to conſtruct what he terms a calendar of Flora, which was afterwards adapted to this climate by Stillingfleet; which conſiſted in obſerving the firſt appearance of the root-ſcions, or flowers of the uncultivated native vegetables, with directions to ſow the *cerealia*, or harveſt ſeed, when ſuch plants or flowers became viſible. By attention to obſervations of this kind on ſuch ſorts of uncultivated plants in many climates, it is conceived ſuch tables might be conſtructed as would point out the moſt proper times of ſowing the moſt uſeful ſeeds or grains in every latitude and ſituation. And it is added, that another tabular view of the climates where plants grow naturally, and of their native ſituations in reſpect to moiſture or dryneſs, hill or valley, with the kind of ſoil where they were originally found, might alſo contribute to their ſucceſsful cultivation.

The above ſeem to be the objects of nature in the vegetation of ſeeds, in requiring ſuch different lengths of time for arriving at maturity. The particular period in which each ſort of grain, ſeed, or root, may be ſown, or put into the earth, with the greateſt proſpect of ſucceſs, will be noticed when we come to ſpeak of the manner of cultivation in the growth of the different ſorts.

In the depoſiting of ſeeds or roots in the ſoil, it may be neceſſary to pay ſome regard to the depth to which they may be introduced and covered; as upon theſe being ſuitably performed according to the nature of the ſeeds or roots, the qualities of the lands, and the ſtate of the climate, different advantages may be obtained in the early vegetation and ſubſequent growth of the crops.

In ſuch ſeeds or roots as are to be put into the ground in the ſpring months, as there is generally a large proportion of moiſture in the ſoils from the continued rains of the autumnal and winter ſeaſons, it may be unneceſſary to cover them to any great depth; half an inch or an inch may at moſt be ſufficient, ſo as to fully protect them from birds and inſects, for grain, turnip, carrot, and

* Darwin's Phytologia, p. 461.

other ſimilar ſeeds; and for roots, ſuch as potatoes, and others of the ſame kinds, from two to three or four inches, according to circumſtances, may be as much as is requiſite. But, in the early autumnal ſowings, as, from the great diſſipating heats of the ſummer months, there muſt in general be leſs humidity in the earth, it may be uſeful in ſuch circumſtances to have the ſeed buried ſomewhat deeper, as two inches or more, in order that their vegetation may not only be more ſpeedily effected, but their roots more fully guarded from the effects of the froſty nights, which uſually take place ſoon after ſuch ſowings. Beſides, they will thus be more effectually protected from the attacks of birds and other vermin, which are generally more eager and deſtructive from the diminiſhed quantity of food at ſuch periods.

But in general, as we have already ſeen that the proceſs of ſprouting or early vegetating is greatly promoted by the ſeeds being fully ſupplied with oxygen air, it may be the moſt beneficial practice to have them but lightly covered or put into the ſoil, in rather a ſuperficial manner, as by ſuch means they will be the moſt fully ſupplied with atmoſpherical air. And on this account too it may be the moſt advantageous method to have the ſeeds or roots depoſited in the ſoil as ſoon as poſſible after it has been turned up by the plough or the ſpade, as in ſuch circumſtances it muſt, as has before been noticed*, contain the largeſt proportion of atmoſpherical air among its conſtituent particles; which it is obſerved may be neceſſary to ſtimulate into elevation the plume of the embryo plant, as the moiſture of the earth is neceſſary to ſtimulate the root into its elongation downwards †, or in other directions.

The depths of ſuch ſowings may be the moſt perfectly regulated by the uſe of drill machines.

The ſtate of the ſeaſon, and climate, in which grain ſeeds or roots are put into the ſoils, may likewiſe have ſome influence on the crops, as has in part been already explained.

It has been generally ſuppoſed that the beſt practice is that of ſowing in dry ſeaſons, and ſetting out plants in ſuch as are moiſt; but it is obvious that, in ſo far as the ſowing is concerned, this buſineſs ought, in ſome reſpect, to be conducted according to the differences of the qualities of the lands, and the nature of the climate in regard to its warmth, or the contrary. Thus in the drier and more mellow and porous deſcriptions of ſoils, and the more warm and genial climates, it may in many caſes be advantageous not only to ſow in the wet, or rather moiſt ſeaſons, but alſo at more early periods than in ſuch as are more

* Section on Fallowing of Land. † Darwin's Phytologia, p. 461.

retentive of humidity; as from the moifture being commonly, in fuch forts of land, quickly diffipated, a more certain and expeditious vegetation of the feed may in this way be fecured.

But in the more heavy and wet kinds of foils, where the climate is colder, it will conftantly be a more beneficial method to choofe, if poffible, a dry and warm feafon for performing the bufinefs of fowing or putting in the crops, as by fuch means the grain will be more certain of vegetating, and in lefs danger of perifhing by the overabundant wetnefs, and the want of heat, in fuch lands and climates. And it has been well remarked, that in fome clayey grounds much foftened by rain, if the feed be put into holes, and a dry feafon fucceed, an almoft impenetrable cruft may be produced by the quick exhalation of the moifture, and what is termed by farmers the fetting of the clay *; and in this manner the vegetation and early growth of the crop be much retarded, or in a great meafure prevented.

Though it has been ingenioufly fuggefted, that ufeful purpofes in the early vegetation of fome forts of plants may be anfwered by the fowing of the fruits or hufks that furround particular kinds of feeds and berries †, no experiments have yet been made to fhew whether the fowing the chaff, or covering of the grain with it, might not, in particular circumftances of foil and climate, be of utility in affording it warmth and protection in the firft ftages of its growth.

In regard to the nature of the foils, and the crops or kinds of feeds, or plants, that may be cultivated upon them with the greateft chance of profit and advantage, it may be generally obferved, that thefe may be the beft and moft perfectly adapted to each other, fo as to afford the moft abundant and moft valuable produce, by attentively obferving what forts agree moft fully in the nature of their nutritive properties, their ftates of moifture, their condition in refpect to pulverifation or mellownefs, and their fituations in regard to warmth. Thus on all the more light and friable defcriptions of foil, fuch as thofe of the fandy, gravelly, chalky, and mellow loamy kinds, barley, oats, peas, turnips, carrots, and various other forts of green crops, as well as thofe of grain, may be fuccefsfully cultivated; while thofe of the heavy, gravelly, chalky, loamy, marfhy, and ftiff clayey, will be more fuited to the growth of wheat, oats, beans, clover, faintfoin, and other forts of graffes of the artificial kind, as will be more fully feen when we come to fpeak of the rotation of crops, and the methods of cultivation that appear to be the

* Darwin's Phytologia, p. 465. † Ibid.

moſt proper for each kind of crop. But in this buſineſs, beſides the properly adapting the nature of the crop to that of the ſoil, as tillage lands are liable to be injured by the repeated growth of particular ſorts of crops, as thoſe of the grain kinds, there is another circumſtance that ought invariably to be kept in view, which is that of preventing the exhauſtion or deterioration of ſuch lands by the judicious and attentive interpoſition or alternation of ſuch as are ameliorating, either by their ſhade or other properties, or but of a ſlightly exhauſting nature, with ſuch as are more powerful in robbing the ſoil of its nutritious properties; ſuch as thoſe of the green, and which are often termed cattle, kinds, with thoſe of the white or corn kind. In this way, beſides the prevention of injury, in ſo far as reſpects the exhauſtion of the ſoil, advantages may alſo be gained by the land, from the different means of tillage which are thus required.

In regard to the practice of ſowing or putting the ſeed into the earth, different methods are followed, not only in diſtricts where the nature and qualities of the ſoils are different, but in thoſe in which they have much ſimilarity. The moſt general and common mode, as well as that which is more or leſs prevalent in almoſt every part of the kingdom, is that of ſowing or caſting the ſeed over the ſurface of the ground by means of the hand, having it afterwards covered to a proper depth by harrowing. In this method of performing the buſineſs, the moſt uſual practice, eſpecially where the ridges are equal in breadth, and not of too great a width, as five or ſix yards, is that of diſperſing the ſeed regularly over each land or ridge, in once walking round; the ſeedſman, by different caſts of the hand, ſowing one half in going and the other in returning. In doing this, it is the cuſtom of ſome ſeedſmen to fill the hand from the baſket or hopper, which they carry along with them, as they make one ſtep forward, and diſperſe the ſeed in the time of performing the next; while others ſcatter the ſeed, or make their caſts, as they are termed by farmers, in advancing each ſtep. It is evident, therefore, that in accompliſhing this buſineſs with regularity and exactneſs, upon which much of the ſucceſs of the crop muſt depend, there is conſiderable difficulty, and the proper knowledge and habit of which can only be acquired by experience. Wherever this method of putting in the ſeed is had recourſe to, it is conſequently of importance for the farmer either to perform the operation himſelf, or to be careful in ſelecting ſuch perſons as are converſant with the buſineſs, as he may otherwiſe

incur much unneceffary expence in the wafte of feed, and run confiderable rifk in refpect to his crops.

It has indeed been well obferved, that in this way of fowing, even with the moft expert feedfmen, where the lands or ridges are irregular or broader at one end than the other, a confiderable wafte of feed muft always be the confequence; as when turning repeatedly on the fame ridge, and at different parts, they cannot poffibly fcatter the feed with equal regularity as if it was of the fame breadth, and they could regulate their cafts by the line of a particular furrow-flice *.

From the feed in this kind of fowing being fcattered at random over the ground, and of courfe vegetating or coming up without any regularity on every part of the land, the crops cannot derive any great advantage in their growth by after-culture, except in the way of clearing them from weeds by the hand, or fome other fimilar means; but in other methods this is not the cafe, as they can be much improved by hoeing and other means.

It is probably from the eafe and expedition with which crops are put in, in this mode, its requiring little knowledge or expence of machinery, and the bufinefs being capable of being performed in almoft every variety of feafon, as well as circumftance of foil and preparation, that it prevails, in fome meafure, in moft parts of the ifland. It is evident, however, that it is a lefs perfect, as well as lefs economical, method of practice, in many refpects, than thofe that are defcribed below, as the feed can neither be depofited in the foil with the fame exactnefs in regard to depth, regularity, or proportion, nor be fo placed as that the crop may be improved in its growth by culture afterwards. It may, notwithftanding, be practifed with propriety and advantage in cafes where the nature of the land is fuch as not to admit the more perfect methods, either from their being fo extremely ftrong and ftony, or fo very ftiff and tenacious, as to greatly impede and difturb the progrefs and operation of the machinery which is employed, or from the ftate of the feafon being fo wet as to prevent the land from being fown by fuch means. Thus in foils that abound much with ftones; that are very ftiff, wet, and clayey; and in all fuch probably as have been but recently broken up, and are not yet reduced by tillage to a ftate of confiderable finenefs in refpect to their mold; this method muft be had recourfe

* Donaldfon's Modern Agriculture, vol. II. p. 267.

to as being the moſt ſuitable and convenient. And there is another ſituation in which it muſt probably of neceſſity in many caſes be practiſed; which is that in which the extent of ground cultivated under the drill ſyſtem is ſo very extenſive as to prevent a due attention being paid to the after-culture of the crops, by its interfering with the other neceſſary operations of the farm. In caſes of this ſort, as much depends upon the after-management where machinery is made uſe of, it will probably always be better to have ſuch portions as cannot be properly attended to ſown in the broadcaſt method.

This method of ſowing, probably from its being that which was almoſt generally had recourſe to during the infancy of the art of agriculture in this country, has frequently been denominated the *old method*, in oppoſition to that which was afterwards introduced by Mr. Tull. There is, however, reaſon to ſuppoſe that the method introduced, deſcribed, and recommended by that intereſting writer, is not ſo *new* as it has been commonly believed to be; for it has been lately found that it is generally practiſed in the Innacondah diſtrict in the Eaſt Indies, in the culture of all grains except horſe grain, as well as in that of hemp, tobacco, cotton, and the caſtor-oil plant*; and it is ſaid that they both drill and dibble corn of every kind in Arabia, China, and Japan, where their ſyſtem of huſbandry has not undergone any material alteration for thouſands of years.

In the drill method of ſowing, the grain or ſeed is depoſited, by means of ſome ſort of machinery or other, in rows or drills at different diſtances, according to the nature of the crop and the views of the farmer. It of courſe affords the means of diſtributing the ſeed with a much greater degree of exactneſs, both in reſpect to the depth and the regularity of the rows, by which the crops not only vegetate and grow up in a more equal manner, but by cultivation are capable of being more effectually aſſiſted in their after-growth, and at the ſame time there is a conſiderable ſaving in the quantity of ſeed. And as the grain by ſuch means is neither too thickly crowded together, nor too thinly ſcattered in the drills, there cannot be any injury in the weakneſs of the crops from the former cauſe, or loſs from the too ſcanty number of ſtems and ears in the latter, which muſt always be more or leſs the caſe in the broadcaſt method of management. Beſides, from the equality of the depth to which

* Halcott in Communications to the Board of Agriculture, vol. I. p. 350.

the feed is depofited in this way, in addition to the advantages that have been juft noticed, the crops become ripe in a more equal and uniform manner.

In the affifting of the growth of the crop by the frequent ftirring and breaking of the earth about it, for a confiderable part of the time it is upon the ground, benefits muft alfo be derived in different ways. By turning the earth in different directions, the mold muft become, not only more completely pulverifed, but alfo newly and more fully aërated, in confequence of which various nutritious materials muft be more abundantly provided*; while, at the fame time, the foil is rendered more eafily penetrable by the fuperficial roots of the grain, and the power of tillering or fending forth new roots and ftems increafed by the earth being laid up to fuch of the joints of the corn ftems as are immediately above the furface. By this means the fame advantages are, indeed, in fome meafure obtained, as by tranfplanting and fetting the roots of the plants deep in the earth, with confiderable favings in the expence of labour. There are likewife other ways in which utility may be derived in this method of management, as by the more complete deftruction of weeds that takes place, and the harvefting of the crops, in confequence of it, being acomplifhed with more certainty and lefs trouble and expence, as well as by the land being left in a more mellow and productive ftate for the growth of future crops †.

From the fine ftate of pulverifation in which the foil is kept by this method, and its being more free from weeds, advantages may fometimes alfo be gained in the way of preparation for putting fucceeding crops into the ground, which could not otherwife be the cafe.

But though this method of fowing feems to afford advantages in thefe different views, it has not by any means been generally adopted by agricultors, the reafons of which, as fuggefted by an ingenious writer, are the difficulty of bringing common labourers acquainted with the practice, the incorrectnefs of the machinery commonly employed in delivering the feed, and the expence with which it is at firft attended; but there are others which have probably had an equal if not greater effect in retarding its progrefs, as the applying it to lands in an improper condition, both in refpect to quality and the ftate of tillage, and the either wholly or partially neglecting the after-management of the crops, upon which, it is obvious, much muft

* Section on Fallowing of Land. † Exter in Memoirs of the Bath Society, vol. IX.

depend. It is probable alfo, that by attempting too great favings in the quantity of feed, and allowing it to be fown too thinly, both in refpect to the drills and the diftances of the rows, the practice may in many inftances have been brought into difrepute.

It is, however, fufficiently fhewn by numerous comparative experiments *, that where the nature of the ground and the ftate of tillage are fuch as to admit the implements to perform the bufinefs in a proper manner, and where a proper and regular attention is beftowed on the after-management of the crops, it is a method that has not only advantages in the ways that have been mentioned, but much fuperiority in the quantity and quality of the produce, as well as the more perfect tillage of the land.

The forts of land on which this method of putting in the feed may be had recourfe to with the greateft probability of fuccefs, are all thofe of the lighter and more mellow kinds, that are not fo ftrong as to obftruct or impede the operation of the drill, and fuch of the heavy defcriptions as have been brought into a ftate of tolerable finenefs, and are not too wet or ftiff to hinder the action of the machine ; but it can probably feldom or ever be employed to much advantage, except, perhaps, for fome particular forts of crops, on thofe of the heavy and ftiff, wet, clayey, kinds, as the operation muft always be liable to be incompletely performed ; nor on fuch as are of a very ftony nature can it be made ufe of in a proper manner, as the ftones will conftantly be liable to derange the operation of the drill, and render the diftribution of the feed irregular and incomplete.

In very wet feed feafons too, it muft, perhaps, give way in many cafes to the broadcaft method, efpecially on the wet and heavy defcriptions of land, as under fuch circumftances the operations of the drill would fcarcely ever be performed with that regularity and exactnefs which is neceffary.

But in whatever kind of foil, and wherever the method of fowing by the drill is attempted, it will invariably be proper, befides fuiting the crop to the quality of the foil, to proportion the quantity of feed to the nature of the land, and the diftance of the rows to that of the crop, and likewife keep up a conftant and minute regard to the culture of the crop during its growth.

In the fowing of crops by means of drill machines, different diftances in the rows and intervals have been recommended, according to the particular intentions of the agricultor. It is obvious that inconveniences muft be experienced by their

* Amos on Drill Hufbandry.

being either too large or too narrow, as in the former there muft be a great lofs of ground, and in the latter little advantage can be derived in the culture of the crops, while growing. The nature of the land muft probably have confiderable influence in regard to the diftance of the rows, and the manner of drilling. On the dry light forts of foil, whether loamy, gravelly, or chalky, that can be conftantly ploughed and kept upon the flat, as is the cuftom in the eaftern parts of Kent, clofe drilling is probably to be preferred as the moft advantageous *. But on fuch foils as require ridging, fomewhat wider diftances may be proper. An ingenious enquirer on this fubject found, that drilling three rows eleven or twelve inches afunder, on three-bout ridges, generally fucceeded well. The three-bouts, in this way, form a ridge about four and a half feet in breadth; the three rows at the diftance mentioned occupying two feet, and the horfe-hoe, paffing on the fide of each outfide row, at the diftance of three inches, leaves the ridge two and a half feet broad, and the intervals between the ridges about two feet †. It is, however, further fuggefted, from remarking that in thefe cafes the outfide rows always afford the moft vigorous and healthy plants, that two rows only, on two-bout ridges, would be equally productive, and leave the land in better condition.

But whatever may be the moft applicable and moft fuitable diftances, which experiment does not feem to have yet fully fhewn, the very wide intervals of the early practice are to be avoided as improper for all forts of grain crops, both on account of the lofs that muft unavoidably be fuftained by the largenefs of the fpaces, and becaufe the intervals, or fpaces between rows, at much lefs diftance, can, in the improved methods of horfe-hoeing, be ftirred with equal facility and exactnefs.

For various kinds of green crops, fuch as cabbages, potatoes, and others of a fimilar nature, wide diftances muft obvioufly be the moft proper. But the width of the intervals, and the proportion of feed, that have appeared the moft elegible to an intelligent cultivator, after a practice of fourteen or fifteen years, are for wheat, rye, barley, oats, and vetches, on fuch foils as are not very wet, equidiftant rows of one foot, on five or ten feet ridges. And for beans, peas, and turnips, on three-feet ridges, two rows on each, nine inches apart, with intervals of twenty-feven inches ‡.

* Farmer's Tour through the Eaft of England, vol. IV. p. 215.

† Wimpey in Tranfactions of Bath Society, vol. VI. p. 126.

‡ Clofe in Communications to the Board of Agriculture, vol. III.

In refpect to the proportion of feed, it is obferved, that fuch lands as are in high tilth, and on five-feet ridges, will only require three pecks of feed of either wheat or rye, five pecks of barley, oats, or vetches, and one bufhel of beans or peas, to the acre. It is fuggefted, however, that thefe proportions fhould be varied, in the quantity of a peck to the acre, according to the quality of the feed, and the richnefs of the land.

It is remarked by another experienced driller, that in refpect to wheat and barley, the diftance of the rows and the quantity of feed muft greatly depend on the quality of the foil. Where it is poor, the diftance between the rows fhould not be more than about eight inches, nor the quantity of feed more than about nine pecks, being depofited to the depth of two inches and a half. If of a middling quality, the diftance between the rows may be about nine inches, and the proportion of feed eight pecks; and where it is rich, the diftance of the rows fhould not ever exceed ten inches, with a quantity of feed of about feven pecks. The latter fort of grain fhould alfo have a finer tilth, and not be placed fo deep in the foil.

As oats do not tiller fo much as other grains, in drilling them a larger proportion of feed will be requifite*.

It is likewife ftated by the fame writer, that as beans and peas afford plants of a very fucculent nature, they of courfe require a greater diftance between the rows, and more efpecially as they are well fuited to the horfehoeing method of culture. He has conftantly found twenty-four inches to be the moft advantageous diftance for fuch crops, and the depth of about three inches.

In the fowing of turnips, rape, &c. on the poorer forts of foils adapted to the growth of thefe plants, he has invariably found ten inches to be the propereft diftance, and on thofe of the richer defcription twelve. When they are fown at greater diftances, he thinks they are apt to grow too large for keeping any great length of time. If fown at a wider diftance, which may, notwithftanding, be proper on fuch foils as are particularly rich, they fhould therefore be eaten off before the fevere frofts fet in, as large turnips are very liable to be deftroyed by them.

In the putting in of carrot crops by the drill method, fourteen inches between the rows is recommended as the moft proper diftance, the land being flightly harrowed over after the drilling is finifhed†.

* Amos on Drill Hufbandry, p. 190. † Ibid.

The refult of Mr. Arthur Young's enquiries, as ftated in his Eaftern Tour, refpecting the influence of different diftances on the produce in various kinds of crops cultivated in the drill or row method, is fully fhewn in tabular views of different forts of grain, &c.*

* Wheat.

Crops.	Diftance.	Produce. Q.	B	
Mr. Fellowes . .	Eighteen inches .	2	5	
Mr. Arbuthnot .	Four rows, at eight inches on $3\frac{1}{2}$ feet ridges	2	7	Horfe-hoes
Mr. Taylor . .	Ten inches . .	4	0	Ditto
Mr. Reynolds . .	Twelve ditto . .	2	4	
Thanet . . .	Nine ditto . .	4	0	Ditto
Ditto . . .	Equally diftant . .	3	4	Ditto
Mr. Anderfon .	Two rows on 5 feet	1	4	Ditto
Mr. Cowflade . .	Eighteen inches . .	3	4	Hand-hoes
Ditto . . .	One foot . .	3	4	
	Average .	3	1	

Barley and Oats.

Crops.	Sort.	Diftance.	Produce. Q.	B.	
Mr. Arbuthnot . .	Barley	Double rows, 3, 4, and 5 feet ridges	1	7	Horfe-hoes.
Mr. Taylor . . .	Oats	Eleven inches . .	4	4	Ditto
Thanet . . .	Barley	Nine ditto . . .	5	4	Ditto
Ditto . . .	Ditto	Ditto	5	4	Ditto
Ditto . . .	Oats	Ditto	7	0	Ditto
Mr. Pool . .	Barley	Nine inches . . .	6	0	Hand
Mr. Anderfon . .	Ditto	One foot	3	0	
Ditto . . .	Oats	Ditto	3	3	
		Average .	4	4	

Beans.

Crops.	Diftance.	Seed.	Produce. Q.	B.	Following Crops.
Lemington . .	. . . . .	. . .	4	0	Wheat
Mr. Canham . .	Every fourth furrow	$2\frac{1}{2}$	5	4	Ditto, five qrs.
Saxmundham . .	. . . . .	. . .	4	4	
Woodbridge . .	Sixteen or 18 inches	. . .	6	2	Wheat
Colchefter . .	Nine inches . .	. . .	6	4	Ditto
Mr. Arbuthnot . .	Various . . .	2	3	3	Ditto
Dartford . .	. . . . .	. . .	5	0	Ditto
Northfleet . .	. . . . .	. . .	6	0	Ditto
Sittingburn . .	. . . . .	. . .	6	4	Ditto
Feverfham . .	Eighteen inches .	. . .	5	4	Ditto
Beakfburn . . .	Twenty inches . .	. . .	5	0	Ditto

Mr. Taylor

Since these tables were drawn up, many improvements have, however, been made, not only in the mode of drilling itself, but likewise in the implements that are made use of for the purpose, by which considerable effects must have been produced, both in regard to the quantity and the goodness of the produce of crops under the row culture *.

There is, notwithstanding, considerable difficulty in ascertaining the most proper and suitable distances in different cases, as they must of necessity depend

* Farmer's Tour through the East of England, vol. IV. p. 197.

BEANS (*continued*).

Crops.	Distance.	Seed.	Produce. Q.	B.	Following Crops.
Mr. Taylor . .	Double rows, six-teen inches on 4-feet ridges.	. .	4	0	Barley
Preston . . .	Eighteen to 24 inches	. .	5	0	Wheat
Thanet . . .	. . . .	. .	4	4	Ditto
Ditto . . .	Sixteen to 24 ditto	. .	4	4	Ditto
Ditto . . .	. . . .	. .	4	0	Ditto
Dover . . .	Eighteen ditto	. .	4	0	Ditto
Sandgate . .	. . . .	. .	4	0	Ditto
Mr. Turner . .	. . . .	. .	5	0	
Mr. Anderson . .	. . . .	. .	1	3	
Donnington . .	Eighteen ditto .	. .	4	4	
Mr. Cowslade . .	. . . .	. .	4	4	
	Average .		4	4	

PEAS.

Crops.	Distance.	Produce. Q.	B.	Following Crops.
Tring . .	Two feet . .	4	3	Wheat
Mr. Booth . .	. . . .	1	4	
Woodbridge . .	. . . .	3	4	
Colchester . .	. . . .	4	0	Wheat
Mr. Neal . .	Ten inches . .	3	0	
Dartford . . .	. . . .	5	0	Wheat
Northfleet . .	. . . .	5	4	Ditto
Sittingburn . .	. . . .	3	4	Ditto
Beaksburn . .	Twenty inches .	3	4	Ditto
Thanet . .	Sixteen to 24 inches	4	0	Ditto
Ditto . . .	. . . .	4	0	Ditto
Mr. Anderson . .	Twenty inches .	1	1	
Mr. Coombs . .	. . . .	3	6	
Donnington . .	Fifteen inches .	4	0	
Mr. Cowslade . .	. . . .	4	4	
Reading . . .	Eighteen inches .	3	4	
Harleyford . .	. . . .	3	4	
	Average .	3	5	

in a great meaſure upon the nature and ſtate of the ſoil, as well as that of the crops.

It is obvious, however, that for grain crops, ſuch as wheat, barley, &c. from the vaſt loſs of ground that muſt take place, the great diſtances practiſed by Tull can ſeldom if ever be had recourſe to with advantage. The experience of drillers in general ſeems indeed to have ſhewn, that on moſt ſorts of ſoil that are ſuited to that method, and eſpecially thoſe of the light and dry kinds, the drilling in cloſe rows, or at narrow diſtances, is by much the moſt beneficial mode. It has been obſerved, in reſpect to the firſt practice, or that of rows from three to four or five feet apart, that if after a period of eighty years it has been capable of making few converts to continue it for any length of time, the preſumption is, that there is ſomething wrong in either the principle or practice; and if the former be juſt, which cannot be diſputed, the error muſt be in the practice *. Others have likewiſe contended, that though the method of cloſe rows is advantageous, the broadcaſt plan greatly exceeds the ſyſtem of wide intervals †.

The diſtances between the rows, and the proportions of ſeed to the acre, that have been found by an experienced drill cultivator to afford the beſt and largeſt crops, are from eight to twenty-eight inches in the intervals, and from ſeven or eight to ſixteen pecks of ſeed, according to the quality of the land and the nature of the crop ‡.—Some latitude may, however, be admitted, as the circumſtances of the caſe vary ||.

A very able and intelligent agricultor, who has paid much attention to the cultivation of crops in drills, has from great experience found, that for white corn crops nine inches anſwer extremely well, but that for peaſe, tares, turnips, and other ſimilar crops, eleven inches is the diſtance that ſucceeds the beſt, and that for beans eighteen inches are not more than is neceſſary ¶. It has likewiſe been found in reſpect to this laſt ſort of crop, by others accuſtomed to the row

* Donaldſon's Modern Agriculture, vol. III. p. 93.

† Farmer's Tour through the Eaſt of England, vol. IV. p. 215.

|| Amos on Drill Huſbandy, p. 207.

¶ Cloſe in Communications to the Board of Agriculture, vol. III.

‡

	Wheat.		Barley.		Oats.		Beans.	
Kind of ſoil.	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.
	Pecks.	Inches.	Pecks.	Inches.	Pecks.	Inches.	Pecks.	Inches.
Pooreſt	10	8	12	8	16	8	12	18
Poor .	9	8	10	8	14	8	10	20
Rich . .	8	9	8	9	12	9	9	24
Richeſt .	7	10	7	10	10	10	8	28

ſyſtem, that when drilled in two rows at nine inches, with an interval of twenty-ſeven, if weeded ſufficiently early, and ploughed between in the method recommended by Mr. Cook, it becomes extremely thick and fine *.

When clover, or other graſſes, are grown with barley crops, it has been aſcertained by long experience by an ingenious cultivator, that the moſt ſure way of obtaining ſuch graſs crops, without the barley being injured, is that of ſowing the graſs ſeeds juſt before the laſt horſe-hoeing. The barley in this method being twice horſe or hand hoed, previous to ſowing the ſeeds, will, it is ſuppoſed, not only be clear from annual weeds, but a fine tilth be obtained for the ſeeds; the blades of corn meeting over the intervals will protect the young plants from the depredations of the fly, and from the ſcorching ſun; the moiſture of every dew will be retained under the ſhade of the corn; and the ſeeds, by being ſown a month or ſix weeks after the barley, will never exhauſt themſelves too much the firſt ſummer, nor riſe ſo high as to interfere with harveſting the barley. It is added, that in a moiſt ſeaſon, when the ſeeds are ſown early with the barley, the land is frequently full of annual weeds; the young plants of clover are often taken off by the fly, and, if they flouriſh, expend themſelves ſo much, that when you expect a full and firſt crop of clover, you have ſomething like a ſecond year's cut, and many fields of barley have been rendered uſeleſs for all the purpoſes of malting, by having ſo large a portion of rich ſucculent clover in the crop, as to prevent their being harveſted †. The propriety of this practice appears alſo to be further confirmed by the ſucceſs of the ſame agricultor in drilling lucern between the rows of barley after the laſt horſe-hoeing, in the proportion of five pounds of ſeed to the acre. In this method the young plants were ſo protected by the ſhade of the barley, and ſo conſtantly kept moiſt by the dews, that it is aſſerted they ſuffered nothing from thirteen weeks dry weather ‡.

The practice of ſowing clover over the drilled barley crops, and covering it by the laſt hoeing, whether it be by the hand or horſe, has been long ſince conſidered of much importance, and far ſuperior to the uſual method of rolling it in §.

It is likewiſe evident, from the ſtatements of the firſt-mentioned writer ‖, that larger crops of barley may be procured by drilling with intervals of a foot,

* Exeter in Bath Memoirs, vol. IX.

† Cloſe's Eſſay in Communications to the Board of Agriculture, vol. III. p. 62. ‡ Ibid.

§ Farmer's Tour through the Eaſt of England, vol. IV. p. 213.

‖ In 1799, he ſays, he put a field, ſoil a ſtrong loam, on to three-feet ridges. In June of that year, he carted fourteen loads of long ſtraw dung, ſpread it in the furrows of thoſe ridges, and with one bout of the plough covered the dung, and formed the ridges over the furrows. On theſe he

than by the broadcaſt method; a point that has been much doubted by ſome cultivators.

In regard to the implements that are employed for the purpoſes of drilling, they are various, according as they are intended for the preparation of the land, for the putting in of the ſeed, or for the cultivation of the crops afterwards. In thoſe made uſe of for drilling, there is alſo conſiderable variety

planted cabbages two feet and a half from plant to plant, and three feet intervals. Theſe were ploughed between, horſe and hand hoed, and the crop a very good one. By Chriſtmas he had cut and carted the cabbages. He then levelled the ridges, and ploughed the land acroſs them ſeven or eight inches deep, with two horſes and a common Suffolk plough. Early in the month of April, 1800, he harrowed the land acroſs, with Mr. Cook's fixed harrow, the driver ſtanding on the harrow, and preſſing the tines four inches into the ſoil. A few ſurface weeds appearing, he ſkimmed the land, without turning a furrow, with the ſcufflers, followed by the roller; and then with the fixed harrow loaded as before, in a different direction, obtained a garden tilth five or ſix inches deep, as far as the froſt had penetrated; below which, the loam was wet and cold. From this land he obtained eight quarters one gallon of barley, weighing fifty-five pounds each Wincheſter buſhel; and two tons three hundred and thirty-three pounds of ſtraw. But as he was determined to aſcertain the money produce of his barley, he diſpoſed of the whole crop, though he never before ſold a load of ſtraw.

	£.	s.	d.
Seven quarters and a half of beſt barley, ſold at four pounds four ſhillings, .	31	10	0
Four buſhels of droſs ſold for	1	1	0
Two tons three hundred and thirty-three pounds of ſtraw ſold for . .	5	10	0
Produce of the acre	38	1	0

The produce of the whole field was, it is aſſerted, at leaſt equal to the acre which was meaſured; as a collateral proof of this, the tithe-owner refuſed three guineas per acre for the tithe of the barley, excluſive of the ſtraw.

It is ſtated that the trifling expence of tillage for obtaining this produce, eſtimating every horſe employed at two ſhillings per day, and every man at the ſame rate of wages, was only the following:

	£.	s.	d.
Firſt ploughing per acre, by two horſes	0	6	0
Harrowing per acre	0	0	9
Scuffling	0	1	0
Rolling with a five-foot roller	0	0	9
Harrowing	0	0	9
Drilling	0	0	9
Harrowing to cover the ſeed	0	0	9
Scarifying the corn, firſt operation	0	0	9
Second ditto	0	0	9
Horſe-hoeing	0	0	9
Rolling twice, after the corn was ſcarified . . .	0	1	0
	0	14	0

The

arifing from the particular kind of crop that is to be fown*. In the preparing of the land, and rendering it fufficiently fine to admit the operation of the drill, befides a common light *fwing plough*, it will be neceffary to be in poffeffion of a *cultivator*; that which is conftructed and fold by Mr. Cook, feems extremely well adapted to the purpofe of breaking down and reducing the particles of ftiff foils. It confifts of a diagonal beam, into which are inferted a number of fhares of different kinds, according to the ufe it is intended to ferve, and from which, as has been already feen, it is differently denominated †. It is capable of being employed with different numbers of tines or teeth, as from three to feven, in proportion as the foil is in a clean or foul ftate, or is of a light or tenacious quality. It is alfo well contrived for affording at once a confiderable degree of pulverifation to the foil, and at the fame time of clearing it from the roots of weeds. It is ftated by an intelligent cultivator, that as the chief defiderata in tilling land are thofe of pulverifing, expofing, cleanfing from weeds, and ridging up, in order to keep the land in a dry and healthy ftate, and for the purpofe of fowing, they may every one of them, except the laft, be fully at-

* Section on Implements. † Ibid.

The tillage to have only prepared the land for a crop of barley in the moft approved method in Hants, would, it is faid, have been:

				£.	s.	d.
Two ploughings with four horfes, a man and a boy, at eleven fhillings each per acre				1	2	0
The feed earth, with three horfes, a man and a boy				0	9	0
Three times dragging				0	3	0
Rolling once				0	0	9
Sowing feed				0	0	3
Harrowing, to cover ditto, with light harrows				0	0	6
Rolling once with a light roller				0	0	6
Expence of tillage, in the ufual method				1	16	0
Three bufhels of feed per acre, at the prefent price of barley				1	11	6
Expence of tillage and feed				3	7	6
In the new hufbandry tillage	0	14	0			
Seed fix pecks	0	15	9			
				1	9	9
Advantage in tillage and feed in favour of the new hufbandry, per acre				1	17	9

It fhould alfo be confidered, he fays, that the quantity of barley he ufually drills upon an acre is one bufhel, but being apprehenfive, from the wetnefs of the preceding harveft, left the feed fhould not all vegetate, he drilled fix pecks. This land never before in the memory of man yielded more, it is remarked, than four quarters per acre.

tained at half the ufual expence, by making ufe of the *tillage fcarifier* *. The furface weeds may be effectually eradicated and removed by fkimming the land, by means of the broad fhares or fcufflers. The writer juft mentioned alfo ftrongly recommends an implement which he terms a *fixed harrow*, as being capable without any other tool of preparing lands that had been formed into ridges during the autumn or winter, for every fort of corn crop of the fpring kind. This is found to pulverife and reduce the furfaces of fuch foils as have been expofed to the action of the frofts, to the depth of four or five inches, without bringing up the cold unproductive earth that lies below.

The *extirpator*, defcribed in the fection on Implements, may likewife be employed for the fame purpofes with much advantage, as it is capable of reducing the fuperficial parts of the foil into a fine condition, to fuch depths as may be thought neceffary, and at the fame time of clearing it from weeds. It may be made ufe of on almoft any fort of land; and, from the particular nature of its conftruction, is adapted to difpatch much work in a fhort fpace of time.

When the land is of a ftiff and lumpy, or cloddy nature, it may alfo frequently be neceffary to have recourfe to *fhims*, in order to break down and feparate the particles, and bring them into a lefs lumpy ftate.

In fome parts of the county of Kent, where the feed is fometimes fown without a drill machine, an implement is often employed which they term a *ftriking plough*, by which little drills or channels are formed in the ground for the reception of the feed, about ten inches diftant from each other, and at fuch depths as are thought neceffary for the particular fort of crop that is to be fown. It is ufually drawn by two horfes, one before the other, with two men, turning at the headlands alternately to the right and left. In order that the drills or channels may be parallel to each other, and of an equal diftance, it is neceffary to keep the infide wheel in the middle of the outfide drill or channel. The work of from two to three acres may, it is faid, be performed in the courfe of a day with this tool.

The *drill roller* is likewife a tool applied for the fame purpofes, the rings with which it is furrounded forming the drills or channels in the ground. It may alfo, as has been feen †, be made ufe of to reduce the lumpinefs of foils.

There are a great number of machines of the drill kind in ufe, moft of the drilling diftricts of the kingdom being poffeffed of particular kinds that

* Clofe in Communications to the Board, vol. III. p. 66. † Section on Implements.

are preferred by them. It has, however, been fufficiently fhewn in the fection on Implements, that the chief points to be attended to are thofe of fimplicity of conftruction, and their depofiting the feed with regularity and exactnefs without bruifing or in any way injuring it during the procefs. Thofe which appeared to us the moft perfect in thefe views have been defcribed, and may be feen by confulting the plates.

An implement fomewhat of this nature has been invented and ufed by Mr. Ducket, a very intelligent drill farmer, which has five fhares, which ftrike out as many drills or channels, on ridges prepared for the purpofe, in the ground, into which the feed is equally delivered from a fort of machine, termed a dropping box; or it may as in the above methods be broadcafted into the fmall furrows or drills made by the implement.

For drilling all forts of grain crops, the implements which have been already defcribed are, fo far as we have had opportunities of enquiring, the moft perfect that have yet been invented*. Some of them, as that of Mr. Cook's invention, being very generally employed in many of the counties where drill hufbandry is practifed.

A drill harrow, the invention of an ingenious agriculturist †, who has made many ufeful experiments in drill hufbandry, from its great fimplicity of conftruction would feem to deferve notice. It has fomewhat the form of a triangular harrow, upon which are fixed two hoppers or feed boxes, the delivery of the grain or feed being performed by means of a fluted nut in the bottom of the hoppers, fo adapted to the apertures as to work without the neceffity of a brufh. It is capable of fowing eight rows at a time, at nine inches diftance. There is a double row of deliveries put in a diagonal pofition, to which motion is communicated by means of a wheel. This is effected merely by a new application of the univerfal joint. It is faid to perform its work with much facility and exactnefs ‡.

In addition to thofe that have been already mentioned as adapted to the drilling of bean, pea, and other fimilar crops §, it may be neceffary to obferve, that there are different fimple implements conftructed for regularly depofiting thefe forts of feeds in drills or fmall furrows. In the county of Middlefex, we have feen drills of this fort made fomewhat in the form of the very light fort of fwing ploughs; but without a coulter, having a fmall kind of feed-hopper attached to the furrow fide of the body of the plough, with the end

* Section on Implements. † Hutchefon Mure, efq.

‡ Young's Annals of Agriculture, vol. XXII. p. 361. § Ibid.

of the axle of a ſmall light wheel that runs on the landſide, paſſing through the loweſt part of it, and ſo contrived as to regulate the proportion of the ſeed according to the intentions of the perſon who has the management of it, and of being lifted up and prevented from ſowing at pleaſure. It may be drawn by one or two horſes, according to the nature of the land. It is ſaid to anſwer well, diſtributing the ſeed with much regularity and exactneſs.

An implement that differs in ſome reſpects from the above, but which has been found to be extremely uſeful for ſowing theſe ſorts of crops, has alſo been lately deſcribed in an intereſting periodical work *. The plan is perfectly ſimple. It conſiſts of a ſort of barrow or hopper, fixed between the ſtilts or handles of a ſmall ſwing-plough, which ſerves to draw the channel or furrow for the reception of the ſeed. The wheel, which in this drill is very ſmall, runs in the track formed by the plough-head, but ſo cloſe to it as not to be liable to be obſtructed or put out of its courſe by the intervening of clods or lumps of earth, as is often the caſe in other machines. It is capable of being prevented from ſowing at pleaſure by the wheel being raiſed, which is eaſily performed by means of a ſmall chain, which is attached by a pin to the right-hand ſtilt. The advantages of this application of the drill-barrow are aſſerted from actual trials to be, that while it is fully effectual in ſaving the labour of a perſon to wheel it, the ſeed is depoſited in the moſt regular and exact manner. This method of working the implement, it is obſerved, has been firſt practiſed by Mr. Lyon, a farmer, at Weſter-Drylow, in Mid-Lothian, on his own farm †.

It is likewiſe ſuggeſted, that a roller for ſowing turnip ſeed may be applied to the ſame implement.

It may notwithſtanding be obſerved, that in all theſe ſorts of drilling implements, one principal defect is, that of their only ſowing or depoſiting one row at a time.

There is alſo a ſort of ſmall *drill-plough* that may be of much advantage in the cultivation of turnip and other crops of a ſimilar nature, as it is ſo con-

* Farmer's Magazine, vol. II. p. 162.

† It is remarked in the above work, that this improved drill-barrow is made in a very correct manner, at the moderate price of eighteen ſhillings, by Meſſs. Brown, coach makers, Abbey-hill, Edinburgh ; who alſo will, if required, make an indented roller for plan ing potatoes by the ſame machine, which it is obſerved is now practicable from the new mode of cutting the ſeed by a ſpherical inſtrument, which, with the cutter itſelf, coſts three ſhillings more, and is made to fit the box in the ſame manner as the fluted roller for ſowing the beans, and takes out and may be put in occaſionally.

trived that a much greater depth of cultivated ſoil may be provided for the reception of the roots of the plants, than in the uſual methods, without the expence being in any way increaſed. In working it, one furrow is to be drawn ſtraight the whole length of the field, and the proper proportion of dung being then placed in it, every ſubſequent turn or bout of the plough is ſaid to form a new ridge, gather the dung, and bury it in the middle of it, and alſo make a drill, as well as depoſit the ſeed in it, and afterwards cover it, forming every ridge equally of the ſame height, and ſimilar in every other reſpect. In order to accompliſh this in the moſt perfect way, the land ſhould, however, it is obſerved, be in a fine ſtate of tillage. The plants being ſet out to ſuitable diſtances by drawing a common hoe acroſs the ridges, it will likewiſe, it is remarked, perform the buſineſs of hoeing in the moſt perfect and expeditious manner. It conſiſts of a ſmall wheel, with a ſeed box, which is fixed on a ſpindle at the end of the axle, and in this way delivers the ſeed at the diſtance which is required; the whole is attached to a very light ſwing-plough. Where the ridges have been previouſly formed with two boxes, one at each end of the ſpindle, two rows may be conveniently ſown at a time. And if in the room of the hoe a plough with a double mold-board be made uſe of, with the ſame apparatus, the ridge is formed at the ſame time that it is drilled, one box only being made uſe of in this caſe.

As in diſtricts where the practice of ſowing grain or other ſorts of crops in drills or rows does not much prevail, there may frequently be a difficulty to comprehend the number and kind of implements of this ſort that may be neceſſary, it may be proper to afford ſome idea to the cultivator on the ſubject. It will, in general, be found that the nature of the ſoil, and the kind of crops that are to be grown, will have conſiderable influence in directing the choice of implements. It has, however, been ſuggeſted by an able cultivator who has had much experience in putting in different ſorts of crops in the drill method, that in order to keep one hundred acres of arable land in high tilth, and regularly cropped, two Suffolk ploughs, one cultivator complete, one beam and handles, with only the tillage ſcarifiers, one fixed harrow, one drill with corn ſcarifiers, and a ſet of flat hoes, with five horſes, would be required. And in addition, he would recommend two pairs of wheels with axes, independent of the drill wheels, which he would never uſe but for the purpoſes of drilling, except on very particular occaſions. Of other kinds of implements, he thinks it almoſt unneceſſary to mention that one ſtrong waggon, one of the light harveſt kind, with three dung carts, one common pair of harrows, and two rollers,

one very heavy but only about five feet long for the purpose of following the scarifiers, and another of the common sort for passing over the corn crops in the spring of the year, would also be wanted. And it is added, that though the cultivator and fixed harrow may with propriety be considered as appendages to the drill, they are nevertheless applicable to the broadcast system of husbandry, and that if generally employed they would save more than one half the common expence incurred for tillage *.

In addition to the above, it is probable that in particular cases some of the smaller sorts of drills, such as those constructed for putting in bean, pea, and turnip crops, might also be necessary, as it is often troublesome and inconvenient to employ the larger drills for such purposes. Where a great variety of crops are cultivated, other sorts of hoes besides those of the flat kind will likewise frequently be requisite, as will be seen when we come to speak of the nature of hoeing, and the kinds of implements best suited to the purpose in different cases.

There is still another method of putting the seed into the ground, besides those that have been already noticed, and which is certainly both simple and exact when attentively performed; but which, since drill machines have been brought to a greater degree of perfection, as it requires a great number of labourers, can probably be only employed to advantage in populous districts, and where the value of labour is not high. This is that of dibbling or setting the seed singly by the hand, a practice that was known and slightly employed at an early period of the art in this country, and which has lately been restored by an intelligent agriculturor †. It would seem to have been introduced into the county of Norfolk, where it has since been practised to a considerable extent, about twenty years since, by the cultivator of a small farm in the vicinity of Norwich. Since that time it has extended itself into different neighbouring districts, as those of the counties of Suffolk and Cambridge, and is also said to be practised in Lincolnshire, with success ‖. In this mode of putting the grain in, it is usual where the land is of the light and mellow kind, to pass a roller over it, before the business of planting is begun; the labourer then, with a small iron-pointed dibble, about three feet in length, in each hand, makes in moving backwards two rows of holes in each furrow slice that has been turned up by the plough, at from four to six inches distant from each other, according to the circumstances of the case, and

* Close in Communications to the Board of Agriculture, vol. III. p. 67.

† Varlo's Yorkshire Farmer. ‖ New Farmer's Calendar, p. 332.

about two or three inches apart in the rows, having the depth of from one to two inches. The perfon who is employed in making thefe holes is then followed by others who drop one, two, or three grains into each hole, as it may fuit the intentions of the planter. This part of the work is moftly performed by women and children. The whole is completed by running a bufh or light common harrow over the field *. In this way an expert dibbler, with three active affiftants, is capable of fetting half an acre of wheat, and three quarters of an acre of barley, oats, or peafe, a-day †. For wheat, in fome diftricts, a narrow fet-plough of only feven inches width at bottom, is ufed to plough with; a one-horfe roll then follows to level the flag, or furrow, for the dibblers, who ftrike only one row upon each: when the wheat is depofited, *two or three kernels in each hole*, a two-horfe roll follows, and afterwards the harrows twice in a place; when the field is finifhed in this manner, it is harrowed up again obliquely: by this method the wheat is depofited in the middle of the flag, at nine inches diftance in the rows; and when come up, has the appearance of being drilled; the two-horfe roller is fuppofed of material ufe in clofing up the holes, and preventing the wheat from being difturbed by harrowing; and the land is made fo folid by rolling, that very little apprehenfions are entertained about the flug or worm. If there fhould be occafion to hoe in the fpring, the operation can be eafily and cheaply performed. Bufh-harrowing is fuppofed of very little ufe; as it can only fweep the duft or light mold over the holes, and in the firft fhower of rain that follows moft of them will be feen, and much of the wheat be fwelled out of them ‡.

For peas, beans, or other fimilar crops, it will obvioufly be neceffary to have larger fpaces between the rows, and greater diftances in them, which muft render a larger portion of ground capable of being planted in a given time. When the children engaged in performing the work of dropping the feed into the holes, are only able to drop into one hole, fix are required to follow one dibbler; when capable of dropping into two holes, three are fufficient for one dibbler; and where they can drop into three holes, two are only requifite for a dibbler. The wages are various according to thefe circumftances; for thofe who perform in the firft manner, it is generally three pence a-day for each child, in the fecond it is feven pence, and in the third about ten pence halfpenny.

Four men to perform the bufinefs of dibbling, with a fuitable number of

* Modern Agriculture, vol. III. p. 83.

† Burroughes in Appendix to Norfolk Report.

‡ Young's Agricultural Report of Suffolk.

droppers, are confidered as fufficient to work in one party, which is a much better practice than that of allowing the whole to work together, as the feed is fet with much greater regularity and exactnefs *.

The expence of performing the bufinefs of planting in this manner, is generally about nine or ten fhillings an acre for wheat, eight for barley and oats †, and feven for peas or vetches †; but this muft evidently be liable to confiderable variation, according as the fituation is populous, and the price of labour cheap, or the contrary.

In fome of the dibbling diftricts, the difficulty and expence of the hand method have been attempted to be leffened by the ufe of machinery, fuch as rollers of the drill and fpiked kind. The manual practice is, however, to be preferred where labourers can be procured. This circumftance of ufing implements for the purpofe of putting in the corn, has probably led fome to fuppofe that the practice of dibbling was more on the decline than is perhaps really the cafe.

The kinds of foil on which this method of putting in the feed has been practifed with the moft advantage, are the light and mixed fandy, and thofe of a loamy quality. On the deep ftiff clays, it is feldom had recourfe to. The newly broken up lands of almoft all defcriptions may, in moft cafes, be advantageoufly planted in this method.

Various forts of crops have been found capable, in particular fituations and circumftances, of being put into the ground in this way with advantage, fuch as thofe of wheat, barley, oats, peas, beans and vetches; the firft is, however, the kind of crop for which it is the moft commonly employed. Oats may, in many cafes, be beneficially dibbled on fuch lands as have been newly ploughed up from leys. But it is fuppofed by fome, that barley can feldom be dibbled, by reafon the land is fo dry in April that the holes will run in, and not ftand open to receive the feed ‡.

In the more fouthern parts of the kingdom, the moft favourable feafon for putting in wheat, in this mode, has been found to be the latter end of September, or the beginning of October; the months of March and April for barley and oat crops; and for peas and beans as early in the fpring months as the nature of the feafon will admit.

The quantity of feed that is required in this method of putting it into the ground, is confiderably lefs than where the broadcaft, or perhaps even the

* Baker in Norfolk Report. † Ibid. ‡ Young's Agricultural Report of Suffolk.

drill fyftem, is followed; but the favings muft conftantly depend, in a great degree, upon the fteadinefs and accuracy of the perfons employed in dropping the feed, and the number of the feeds that are put into each hole. It has been fuggefted by an experienced cultivator in this way, that where the droppers are properly attended to, the faving in wheat may be about fix pecks in the acre, in barley eight, and in peas and vetches about four *.

The number of grains that are depofited in each hole, is different in different circumftances, but the moft general practice, and that which has been found the moft fuccefsful, is three or four for grain crops, and one or two for thofe of peas, beans, and others of the fame kind †. It is evident, however, that they fhould neither be fet too thickly, nor in too thin a manner: as in the former cafe the plants may be drawn up, and the crops in confequence become weak and not productive; and in the latter, as where only one grain is placed in each hole, they may be fo thin as to afford but a fcanty produce from the want of plants. Where due care has been taken in the putting in of the feed, there is moftly a confiderable increafe of produce in this way of fowing over the others. The exact amount of the additional produce that is thus obtained, has not, however, been fully fhewn by the experiments of intelligent cultivators; but it has been fuppofed, in refpect to wheat, to be from four to fix bufhels in the acre ‡, and the refult of an experiment made with the view of afcertaining the difference in the produce between fowing and fetting barley, proves it to be ftill greater in that fort of grain, the experimenter having had twelve bufhels on the acre more in the land that was dibbled, than that which was fown §. Conclufions drawn from loofe eftimates, or fingle experiments, cannot, however, be depended upon, but it can fcarcely be doubted that the quantity of produce is greater in the method of dibbling the feed than in fowing it broadcaft. In the quality of the grain there is likewife a fuperiority: the wheat and barley produced in this way are faid to be not only more free from drofs, but larger in the kernel, and of courfe weighing confiderably heavier ‖. It is eafy to perceive, that when the feed is put into the foil in the regular and equal manner that is the cafe in fetting with the hand when well performed, the crops, of whatever kind they may be, may have a fuperiority in thefe different refpects, both from the plants in fuch inftances being lefs crowded together, and their becoming in confequence

* Baker in Appendix to Norfolk Report.

† Varlo in ditto.

‡ Burroughes in Norfolk Agricultural Report.

§ Baker in ditto.

‖ Ibid.

more ſtrong and vigorous, and from the air and ſun being more fully admitted, by which they become more equally, as well as more perfectly, ripened. It is probable too, that in ſuch caſes, from the greater regularity of the plants, the hoeing or after-culture of the crops, where it is practiſed, may be more effectually and more fully performed. There is alſo another reaſon, that in particular inſtances has been ſuggeſted as the cauſe of the quality of the grain, in this mode of ſowing, being ſuperior, which is that of wheat being frequently dibbled upon ſuch land as has been broken up from a new clover ley, in which caſe the ſeeds being ſet in the furrow ſlice, or flag, the plants are not liable to be obſtructed in their growth; whereas, when ſown in the uſual broadcaſt method, much of the ſeed muſt of courſe fall into crevices and openings between the furrow ſlices, where they muſt be greatly impeded in their vegetation by weeds and other cauſes *. This ſhows likewiſe the abſurdity of putting wheat crops in by the broadcaſt method upon ſuch preparations of land.

The practice of dibbling peas and beans is only met with in particular diſtricts to any great extent. In the county of Glouceſter, where it prevails in a conſiderable degree, the buſineſs is chiefly performed by women. In Middleſex and ſome other counties, both men and women are, however, employed in this ſort of field work. In executing this operation with crops of theſe kinds, it is the cuſtom in ſome places to form the rows acroſs the ridges, but in others, the lengthways of them. The latter method is probably the beſt, as the planters may be kept more perfectly diſtinct from each other; and the ſeed be put into the beſt part of the mold in the furrow ſlice, while in the former it muſt frequently be liable to be put into the looſe earth in the ſeams or interſtices formed by the furrow ſlices, and thus be provided with a leſs ſuitable bed for vegetating in. With ſome ſetters, it is likewiſe a practice to make uſe of a line in order to guide them in placing the rows at equal diſtances, but thoſe who have been much uſed to the buſineſs ſeldom find it neceſſary. In performing the work, the ſetters, beginning each at the end of a row, and forming holes at the diſtances of about two or three inches from each other, and of nearly the ſame depths, introduce one or two peas or beans into each hole; proceeding in the ſame manner until the whole is done. The intervals or diſtances between the rows are generally from about ten to fourteen or fifteen inches†.

The proportion of ſeed that is requiſite in this mode of ſowing muſt obviouſly

* Donaldſon's Modern Agriculture, vol. III. † Ibid.

be different according to the number of ſeeds put into each hole, and the differences in the width of the intervals; but from two and a half to three buſhels are the moſt uſual quantities. The expence of this ſort of labour is in moſt diſtricts from about three ſhillings and ſix pence to four ſhillings and ſix pence, or five ſhillings, the acre. After the ſeed has been ſet, the field is moſtly harrowed well over in order to cover it, by means of a light ſort of harrow.

This method of planting, beſides its employing a conſiderable number of poor perſons, the ſaving of ſeed, and the great improvement in the quantity as well as quality of the grain, poſſeſſes other advantages; the ſeed is depoſited to a proper depth in the beſt parts of the ſuperficial ſoil, and in ſuch a manner, where proper attention is paid, as that the greateſt poſſible benefits may be derived from the ſucceeding hoeings of the crops. And in the lighter ſorts of land the treading of the labourers in performing the buſineſs, by preſſing the looſe mold more into contact with the grain, may render it capable of vegetating in a more quick and perfect manner. From the ſeed in this way being placed more in the ſolid or firm parts of the ſoil, it may likewiſe be leſs expoſed to danger from worms, grubs, or other deſtructive animals of the ſame kind. And in many ſorts of grain, as well as peas and beans, the danger of their being brought to the ſurface by harrowing is obviated*. The ſtraw being ſtouter, the crops may be leſs liable to lodge after heavy rains, and leſs expoſed to the danger of mildews†.

It would ſeem obvious from what has been obſerved on the different methods of putting ſeed into the ground, that each of them may poſſeſs a degree of merit, and be uſeful in particular caſes and ſituations of ſoils and crops, but that in general the broadcaſt practice is probably liable to more objection than either that of drilling or dibbling, from its being leſs exact, and the ſeed being diſperſed with ſuch inequality, and in ſo irregular a manner, as to admit of little or no after-aſſiſtance being given to the crops during the period of their growth by hoeing or ſtirring of the more ſuperficial parts of the ſoil about the roots of the plants. It muſt, notwithſtanding, be had recourſe to probably in ſuch caſes and circumſtances as have been already noticed; but wherever it is practiſed, as hoeing is in a great meaſure excluded, the land ſhould obviouſly be in a good ſtate of tilth, and as free as poſſible from the production of weeds; points that have in general been inadequately attended to in this ſyſtem of arable management.

* Experienced Farmer, vol. I.

† Norfolk Agricultural Report, p. 211.

The method, by means of implements of the drill kind, in ſituations, and under circumſtances of ſoil and preparation, where it is capable of being properly had recourſe to, both from the ſeed being depoſited with more exactneſs in reſpect to the depths and the regularity of the rows, as well as from the ſuperior ſtate of tilth that is requiſite in the firſt inſtance, and its eaſily admitting of every kind of culture while the crops are growing, is certainly not only more perfect, but probably better calculated for the affording of full crops, and more adapted to the keeping of the land in the moſt advantageous condition for improved modes of cropping.

And the mode of ſetting or putting the ſeed into the ſoil by the hand, though probably leſs exact than that by the drill machine, except where particularly attended to, and certainly leſs capable of being beneficially employed from the greater expence which it incurs, may, notwithſtanding, as it admits of after-culture, be found an uſeful practice in ſome caſes, eſpecially where the land has been broken up from clover, or any new ley, and is not too ſtiff or adheſive *. It has, however, been ſuggeſted †, that the method of ſowing in drills is to be preferred, from the circumſtance of a greater quantity of earth or mold being turned over, and conſequently air included in larger proportions in the interſtices, as in dibbling the ſides of the holes are rendered more ſolid, and thereby leſs proper for the reception of the tender roots of the young plants.

But the ſuperiority or advantage of any particular method of ſowing or putting crops into the ground, over that of others, will probably be ſhewn in the moſt clear and ſatisfactory manner by the comparative ſtatements that have been given by thoſe attentive cultivators who have inſtituted and conducted experiments on different kinds of ſoils and crops, with the view of aſcertaining a matter of ſo much importance to huſbandry.

In experiments made on two acres of a ſtiff hazel-coloured loamy ſoil, laid up in eleven-feet ridges, worth about twenty ſhillings an acre, and ſown with oats, cole ſeed, barley, beans, and wheat, in the drill and broadcaſt methods alternately, in the rotation of firſt oats, ſecond cole, third barley, fourth beans, and fifth wheat, the ſuperiority of the drill ſyſtem, over that of the broadcaſt, was found by Mr. Amos to be conſiderable, not leſs than from one pound to

* Experienced Farmer, vol. I.

† Darwin's Phytologia, p. 441.

one pound fourteen ſhillings the acre in the grain and pulſe crops, and one ſhilling and ſixpence in that of the cole *.

* The reſult of theſe experiments is given in the following manner:

CROPS.

OATS.

Drilled Acre. DR.

1783.	£.	s.	d.
March 6, Ploughing up from ſwarth	0	5	0
10, Five harrowings and one rolling . . .	0	3	0
Drilling two inches deep, and eight aſunder .	0	0	6
Harrowing after .	0	0	6
Twelve pecks ſeed, at 9d.	0	9	0
April 20, Rolling . . .	0	0	6
May 14, Breaſt hoeing, firſt time	0	2	0
June 5, Ditto, ſecond time .	0	2	0
Hand-hoeing . .	0	1	6
Rent, &c. for one year	1	1	0
	£. 2	5	0

Contra. CR.

	£.	s.	d.
Sept. 19, Crop, fifty-ſix buſhels, at 2s. 3d. . . .	6	6	0
Profit .	£. 4	1	0

Broadcaſt Acre. DR.

1783.	£.	s.	d.
March 6, Ploughing up from ſwarth	0	5	0
10, Eight harrowings .	0	4	0
Seed ſixteen pecks, at 9d.	0	12	0
Sowing . . .	0	0	3
April 20, Rolling . . .	0	0	6
May 24, Hand-weeding, firſt time	0	2	6
June 15, Ditto, ſecond time .	0	3	0
Rent, &c. . .	1	1	0
	£. 2	8	3

Contra. CR.

	£.	s.	d.
Sept. 19, Crop, fifty buſhels, at 2s. 1½d. . . .	5	6	3
Profit .	2	18	0
Superiority of the drill crop . .	1	3	0
	£. 4	1	0

COLE-SEED.

Drilled Acre. DR.

1783.	£.	s.	d.
Nov. 4, Ploughing land acroſs five inches deep . .	0	5	0
1784.			
March 1, Break-harrowing, firſt time	0	1	6
26, Ploughing, ſecond time	0	5	0
April 24, Break-harrowing, ſecond time . . .	0	1	0
Carried forward .	£. 0	12	6

Broadcaſt Acre. DR.

1784.	£.	s.	d.
Four ploughings . .	0	18	0
Six harrowings . .	0	3	0
Two rollings . .	0	1	0
Lime . . .	1	0	0
June 28, Sowing every other land, ſeed, harrowing, &c.	0	1	0
Rolling . . .	0	0	6
Carried forward .	£. 2	3	6

And on two acres of land ridged in the ſame way, but the ſoil of which was a light ſandy loam, worth about eighteen ſhillings the acre, ſown in the

	£.	s.	d.
Brought forward,	0	12	6
Harrowing and rolling	0	1	0
May 16, Ploughing land, third time	0	4	0
30, Lime, 4½ chaldrons charged	1	0	0
Drag harrowing . .	0	1	6
June 12, Rolling and harrowing	0	1	6
28, Ploughing, fourth time	0	4	0
Harrowing, and rolling twice . . .	0	2	0
29, Drilling every other land one inch deep and twelve aſunder .	0	0	6
Seed, a quarter peck .	0	0	6
Harrowing . .	0	0	6
July 24, Breaſt-hoeing, firſt time	0	2	6
Aug. 16, Ditto, ſecond time .	0	2	0
Rent, &c. one year .	1	1	0
Expences . £.	3	13	6
Contra.		CR.	
Nov. 24, Value of crop appraiſed	4	0	0
Profit . £.	0	6	6

	£.	s.	d.
Brought forward,	2	3	6
July 10, Harrowing . .	0	0	6
18, Hoeing, firſt time .	0	3	0
Aug. 12, Ditto, ſecond time .	0	2	6
Rent, &c. one year .	1	1	0
Expences . £.	3	10	6
Contra.		CR.	
Nov. 24, Value of crop appraiſed	3	16	0
Profit .	0	5	6
Superiority of drilled crop .	0	1	0
£.	0	6	6

BARLEY.

Drilled Acre.	DR.		
1784.	£.	s.	d.
Dec. 24, To ploughing, firſt time	0	5	0
1785.			
Lime, charged half .	0	18	0
March 20, Break-harrowing, .	0	1	0
April 1, Ploughing, ſecond time	0	4	0
Harrowing, three times and rolling . .	0	2	0
Drilling ſeed, two inches by nine . . .	0	0	6
Harrowing ditto .	0	0	6
Seed, eight pecks, at 9d.	0	6	0
Carried forward . £.	1	17	0

Broadcaſt Acre.	DR.		
1784.	£.	s.	d.
Dec. 24, Ploughing, firſt time .	0	5	0
1785.			
April 1, Ploughing, ſecond time	0	4	0
Seed, twelve pecks, at 9d. and ſowing . .	0	12	3
May 20, Lime, half charged .	0	18	0
Break-harrowing .	0	1	0
Harrowing four times	0	2	0
Rolling . . .	0	0	6
Carried forward . £.	2	2	9

drill and broadcaſt manner with turnips, barley, clover, and wheat, in the rotation of firſt turnips, ſecond barley, third red clover, fourth wheat; the trials

		£.	s.	d.
	Brought forward,	1	17	0
	Rolling . . .	0	0	6
May 10,	Breaſt-hoeing, firſt time	0	2	0
	Hand-weeding rows .	0	1	0
June 4,	Breaſt-hoeing, ſecond time	0	1	6
	Hand-weeding rows .	0	1	0
	Rent, &c. one year .	1	1	0
	Expences . £.	3	4	0
Contra.		CR.		
Aug. 20,	Crop reaped, and in a few days thraſhed, produce 58 buſhels, at 3s. .	8	14	0
	Profit . £.	5	10	0

		£.	s.	d.
	Brought forward,	2	2	9
	Hand-hoeing firſt time	0	2	6
	Hand-weeding . .	0	2	0
	Rent, &c. one year .	1	1	0
	Expences . £.	3	8	3
Contra.		CR.		
Aug. 26,	Crop reaped, and in a few days thraſhed, produce 51 buſhels, at 3s .	7	13	0
	Profit .	4	4	9
	Gain by the drilled crop	1	5	3
	£.	5	10	0

BEANS.

Drilled Acre. DR.

		£.	s.	d.
1785.				
Nov. 4,	Ploughing, firſt time .	0	5	0
1786.				
March 6,	Break-harrowing .	0	1	0
8,	Ploughing, ſecond time	0	4	0
	Four harrowings at 6d	0	2	0
	Rolling . . .	0	0	6
	Drilling the ſeed three by 24 inches . .	0	0	6
	Harrowing ditto .	0	0	6
	Seed, for 8 pecks, at 10½d.	0	7	0
April 20,	Rolling . . .	0	0	6
	Harrowing . .	0	0	6
May 16,	Horſe-hoeing, firſt time	0	1	0
20,	Hand-hoeing the rows	0	1	6
June 16,	Horſe-hoeing the intervals, ſecond time .	0	1	6
18,	Hand-hoeing the rows	1	1	0
26,	Earthing up ditto, firſt time . . .	0	1	0
	Carried forward . £.	1	7	6

Broadcaſt Acre. DR.

		£.	s.	d.
1785.				
Nov. 4,	Ploughing, firſt time .	0	5	0
1786.				
March 4,	Break-harrowing .	0	1	0
8,	Ploughing, ſecond time	0	4	0
	Sowing the ſeed .	0	0	3
	Harrowing ditto, 5 times	0	2	6
	Seed, twelve pecks at 10½d.	0	10	6
April 20,	Rolling and harrowing .	0	1	0
May 29,	Hand-weeding, firſt time	0	3	0
June 30,	Ditto, ſecond time .	0	1	6
	Rent, &c. . .	1	1	0
	Expences . £.	2	9	9
Contra.		DR.		
Sept. 29,	Produce, thirty buſhels	5	5	0
	Profit .	2	15	3
	Gain by the drilled .	1	1	3
	£.	3	16	6

of the ſame cultivator alſo turned out in favour of the drill method. The advantage in the turnip and clover crops being from eight to ten ſhillings and

Drilled Acre continued.

	£.	s.	d.
Brought forward,	1	7	6
July 10, Earthing up ditto, ſecond time . . .	0	1	0
Rent, &c. . .	1	1	0
Expences .	£. 2	9	6

Contra. CR.

1786.	£.	s.	d.
Sept. 29, Produce, thirty-ſix buſhels, at 3s. 6d. . .	6	6	0
Profit .	£. 3	16	6

WHEAT.

Drilled Acre. DR.

1786.	£.	s.	d.
Sept. 8, Ploughing, firſt time .	0	5	0
Oct. 6, Break-harrowing and weeding . . .	0	3	0
8, Second ploughing .	0	4	0
Harrowing thrice, rolling once . . .	0	2	0
Drilling every other land, and 1-third by 1-eighth	0	0	6
1787.			
Seed, ſeven pecks, harrowing 6d . .	0	9	10
April 20, Rolling and harrowing for weeding . .	0	1	0
May 6, Firſt hoeing intervals, and hand-weeding the rows	0	3	0
30, Second hoeing . .	0	1	6
June 4, Hand-weeding rows .	0	1	0
Year's rent, &c. . .	1	1	0
Expences .	£. 2	11	10

Contra. CR.

1787.	£.	s.	d.
Aug. 24. Produce, 36 buſhels .	9	18	0
Profit .	£. 7	6	2

Broadcaſt Acre. DR.

1786.	£.	s.	d.
Sept. 28, Ploughing, firſt time .	0	5	0
Oct. 6, Break-harrowing .	0	1	0
Gathering weeds .	0	2	0
8, Ploughing, ſecond time	0	4	0
Seed, nine pecks, 1s. 4d.	0	12	0
Sowing ditto . .	0	0	3
1787. Harrowing five times .	0	2	6
April 20, Rolling and harrowing, &c.	0	1	0
May 14, Hand-weeding, firſt time	0	2	6
June 12, Hand-weeding, ſecond time,	0	2	0
Rent, &c. one year .	1	1	0
Expences .	£. 2	13	3

Contra. CR.

1787.	£.	s.	d.
Aug. 26, Produce, 30 buſhels .	8	5	0
Profit .	£. 5	11	9
Gain by the drilled acre	1	14	5
	£. 7	6	2

ſixpence, and in thoſe of the grain kinds, from ſeventeen ſhillings to one pound nine ſhillings *.

* CROPS.

1ſt. TURNIPS.

Drilled Acre. DR.

1789.		£.	s.	d.
Feb. 11,	Ploughing, firſt time .	0	5	0
Mar. 31,	Break-harrowing .	0	1	0
April 28,	Ploughing, ſecond time	0	4	6
May 10,	Harrowing twice .	0	1	0
	Gathering couch .	0	2	6
24,	Ten loads of rotten dung, half charged . .	0	12	6
	Ploughing, third time .	0	4	0
	Rolling . . .	0	0	6
June 16,	Harrowing twice .	0	1	0
	Rolling . . .	0	0	6
18,	Ploughing, fourth time	0	4	0
	Harrowing thrice .	0	1	6
	Rolling . . .	0	0	6
	Drilling ſeed one inch by twelve . . .	0	0	6
	Harrowing ditto .	0	0	6
	Seed, 1lb. ſugar-loaf .	0	0	6
July 20,	Harrowing, firſt weeding	0	0	6
28,	Breaſt-hoeing, ſecond ditto	0	2	0
Aug. 18,	Hand ditto, third ditto	0	2	6
	Rent, one year, &c.	0	19	0
	Expences .	£. 3	4	0

Contra.	CR.			
Dec. 10,	Crop appraiſed . .	3	15	6
	Profit .	£. 0	11	6

Broadcaſt Acre.

1789.		£.	s.	d.
Mar. 1,	Ploughing, firſt time .	0	5	0
31,	Break-harrowing .	0	1	0
April 28,	Ploughing, ſecond time	0	4	6
May 10,	Harrowing twice .	0	1	0
	Gathering couch .	0	2	6
24,	Ten loads of dung, half charged . . .	0	12	6
	Ploughing in ditto .	0	4	0
	Rolling . . .	0	0	6
June 16,	Harrowing and rolling	0	1	0
18,	Ploughing, fourth time	0	4	0
	Three harrowings and one rolling . . .	0	2	0
	Seed, 1lb. ſugar-loaf .	0	0	6
	Sowing ditto . .	0	0	3
	Harrowing and rolling ditto . . .	0	1	0
July 20,	Harrowing for the firſt weeding . . .	0	0	6
28,	Hand-hoeing, firſt time	0	3	6
Aug. 18,	Ditto, ſecond time .	0	2	6
	Rent, one year, &c. .	0	19	0
	Expences .	£. 3	5	3

Contra.	CR.			
Dec. 12,	Crop appraiſed . .	3	8	0
	Profit . .	0	2	9
	Gain by drill . .	0	8	9
		£. 0	11	6

2d. BARLEY.

On land where the foil was a light fandy loam, of the value of about twenty fhillings the acre, managed in the method that has been juft defcribed, the

2d. BARLEY.

Drilled Acre. DR.

1789.		£.	s.	d.
	Charge of dung, half .	0	12	6
Dec. 20,	Ploughing, firft time .	0	5	0
1790.				
Mar. 24,	Break-harrowing .	0	1	0
April 10,	Ploughing, fecond time	0	4	0
	Harrowing thrice .	0	1	6
	Rolling . . .	0	0	6
	Drilling the feed two inches by nine . . .	0	0	6
	Harrowing and rolling ditto	0	1	0
	Seed, eight pecks, at 10d.	0	6	8
May 6,	Hoeing, firft time .	0	2	8
	Hand-weeding rows .	0	1	0
June 16,	Hoeing, fecond time .	0	1	6
	Hand-weeding rows .	0	1	0
	Rent, &c. one year .	0	19	0
	Expences .	£. 2	17	2

Contra CR.

1790.		£.	s.	d.
Aug. 26,	Produce, fifty-two bufhels	9	1	0
	Profit .	£. 6	3	10

Broadcaft Acre. DR.

1789.		£.	s.	d.
	Half the charge of the dung . . .	0	12	0
Nov. 20,	Ploughing, firft time .	0	4	6
1790.				
Mar. 24,	Break-harrowing .	0	1	0
April 10,	Ploughing, fecond time	0	4	0
	Seed, twelve pecks, at 10d.	0	10	0
	Sowing ditto . .	0	0	6
	Harrowing ditto, four times	0	2	0
	Rolling ditto . .	0	0	6
May 20,	Weeding the firft time	0	3	0
June 16,	Weeding, fecond time	0	2	0
	One year's rent, &c. .	0	19	0
	Expences .	£. 2	18	6

Contra. CR.

	£.	s.	d.
Produce, forty-feven bufhels	8	4	6
Profit .	5	6	0
In favour of the drilled crop . . .	0	17	10
	£. 6	3	10

3d. RED CLOVER.

Drilled Acre. DR.

1791.		£.	s.	d.
	Seed, one ftone, laft year	0	7	0
Mar. 29,	Bufh-harrowing 1s. raking and gathering off weeds, 3s. 6d. rolling 6d. .	0	5	0
June 30,	Mowing and making firft crop . . .	0	5	0
	Carting home . .	0	15	0
	Expences on fecond crop	0	15	6
	Year's rent, &c. .	0	19	0
	Expences .	£. 3	6	6

Broadcaft Acre. DR.

1791.		£.	s.	d.
	One ftone of feed .	0	7	0
Mar. 30,	Bufh-harrowing .	0	1	0
	Raking and gathering weeds . . .	0	3	0
	Rolling . . .	0	0	6
	Mowing the firft crop	0	2	6
	Making it into hay .	0	2	6
	Leading ditto home .	0	12	0
	Mowing the fecond crop	0	2	0
	Carried forward .	£. 1	10	6

crops being potatoes, barley, red clover, and wheat, in the courſe of firſt potatoes, ſecond barley, third clover, fourth wheat, the ſuperiority of the drill

Contra. CR.

	£.	s.	d.
Firſt eddiſh . .	0	4	0
Firſt crop, two ton hay	6	0	0
Second ditto, one and a half ton . .	4	10	0
Second eddiſh . .	0	5	0
	10	19	0
Expences .	3	6	6
Profit . .	£.7	12	6

	£.	s.	d.
Brought forward,	1	10	6
Making ditto . .	0	2	6
Leading ditto home .	0	9	0
One year's rent, &c. .	0	19	0
Expences .	£.3	1	0

Contra. CR.

	£.	s.	d.
Firſt and ſecond eddiſhes,	0	8	0
Ditto crops, $3\frac{1}{4}$ tons .	9	15	0
	10	3	0
Expences .	3	1	0
Profit . .	7	2	0
In favour of drilled	0	10	6
	£.7	12	6

4th. WHEAT.

Drilled Acre. DR.

		£.	s.	d.
1791.				
Oct. 4,	Ploughing . .	0	5	0
	Five harrowings and one rolling . .	0	3	0
	Drilling ſeed $2\frac{1}{2}$ inches by nine . . .	0	0	6
	Harrowing ditto .	0	0	6
	Seed, 8 pecks, at 1s. 6d.	0	12	0
1792.				
April 16,	Harrowing and rolling, firſt weeding . .	0	1	0
May 1,	Hoeing the firſt time	0	2	0
12,	Hand-weeding rows .	0	1	6
20,	Hoeing ſecond time .	0	1	6
24,	Hand-weeding rows .	0	1	0
	Rent one year, &c. .	0	19	0
	Expences .	£.2	7	0

Contra. CR.

		£.	s.	d.
1792.				
Aug. 30,	Produce, forty-two buſhels	10	10	0
	Sheep feed April .	0	3	6
		10	13	6
	Profit .	£.8	6	6

Broadcaſt Acre. DR.

		£.	s.	d.
1791.				
Oct. 4,	Ploughing . . .	0	5	0
	Seed nine pecks, 1s. 6d.	0	13	6
	Sowing ditto . .	0	0	3
	Harrowing ſix times .	0	3	0
1792.				
April 16,	Ditto and rolling .	0	1	0
May 12,	Weeding firſt time .	0	3	0
26,	Ditto ſecond ditto .	0	2	0
	Rent one year, &c. .	0	19	0
	Expences .	£.2	6	9

Contra. CR.

	£.	s.	d.
Sheep feed . .	0	3	6
Produce, thirty-ſix buſhels	9	0	0
	9	3	6
Profit .	6	16	9
In favour of drilled .	1	9	9
	£.8	6	6

practice appears ſtill more evident. As the detail of the potatoe crop ſeems principally intended to ſhew the difference between horſe and hand hoeing, it is here omitted *.

* *CROPS.*

1ſt. POTATOES.

Drilled Acre.
Details of omitted.

Broadcaſt Acre.
Details of omitted.

2d. BARLEY.

Drilled Acre.

		DR. £.	s.	d.
1790.				
	Charge of dung half .	0	15	0
Jan. 18,	Ploughing, firſt time .	0	5	0
Mar. 9,	Break-harrowing .	0	1	0
April 10,	Ploughing, ſecond time	0	4	0
	Three harrowings .	0	1	6
	Rolling . . .	0	0	6
	Drilling ſeed 2 by 9 inches	0	0	6
	Harrowing and rolling do.	0	1	0
	Seed, ſeven pecks, at 11d.	0	6	5
May 14,	Hoeing the firſt time .	0	2	0
	Hand-weeding rows .	0	1	0
June 6,	Hoeing ſecond time .	0	2	0
	Hand-weeding rows .	0	0	6
	Rent one year, &c. .	1	1	0
	Expences .	£.3	1	5
Contra.		CR.		
Sept. 4,	Produce, 56 buſhels 3s. 6d.	9	16	0
	Profit .	£.6	14	7

Broadcaſt Acre.

		DR. £.	s.	d.
1790.				
	Charge of dung half .	0	15	0
Jan. 18,	Ploughing, firſt time .	0	5	0
Mar. 9,	Break-harrowing .	0	1	0
April 10,	Ploughing, ſecond time	0	4	0
	Seed, twelve pecks, at 10d.	0	10	0
	Sowing ditto .	0	0	3
	Harrowing ditto four times	0	2	0
	Rolling . . .	0	0	6
May 14,	Weeding firſt time .	0	4	0
June 4,	Ditto ſecond time .	0	1	6
	Rent one year . .	1	1	0
	Expences .	£.3	4	3
Contra.		CR.		
Sept. 6,	Produce, forty-nine buſhels, 3s. 4d. . . .	8	3	4
		4	19	1
	In favour of drilled acre	1	15	6
		£.6	15	7

3d. CLOVER.

Drilled Acre.

		DR. £.	s.	d.
1791.				
	Seed, one ſtone ſown laſt year . . .	0	7	0
Mar. 30.	Buſh-harrowing . .	0	1	6
	Raking and gathering weeds	0	2	6
	Rolling . . .	0	0	6
	Carried forward .	£.0	11	6

Broadcaſt Acre.

		DR. £.	s.	d.
1791.				
	One ſtone ſeed . .	0	7	0
Mar. 30,	Buſh-harrowing .	0	1	6
	Raking and gathering weeds	0	2	6
	Rolling . . .	0	0	6
	Carried forward .	£.0	11	6

The value of the ſtraw in all theſe experiments is ſuppoſed to be adequate to the expences incurred in reaping, threſhing, and conveying the produce to the markets.

It is likewiſe aſſerted, that in a variety of trials conducted in a ſimilar manner, but on lands of very inferior qualities, as ſuch as were not worth more than from twelve to fourteen ſhillings the acre a-year, the advantages were

		£.	s.	d.
	Brought forward	0	11	6
July 4,	Mowing firſt crop .	0	2	6
	Making . . .	0	2	6
	Carting home, &c. .	0	12	0
	Mowing ſecond crop .	0	2	0
	Making ditto . .	0	2	6
	Carting ditto home, &c.	0	9	0
	Rent one year, &c.	1	1	0
	Expences .	£. 3	3	0

Contra. CR.

Produce of the two crops, three tons . .	9	0	0
Firſt and ſecond eddiſh	0	10	0
	9	10	0
Expences .	3	3	0
Profit .	£. 6	7	0

		£.	s.	d.
	Brought forward	0	11	6
June 20,	Mowing firſt crop .	0	2	6
	Making it . . .	0	2	6
	Leading ditto . .	0	10	6
	Mowing ſecond crop .	0	2	0
	Making ditto . .	0	3	0
	Leading ditto . .	0	7	6
	Rent one year, &c. .	1	1	0
	Expences .	£. 3	0	6

Contra. CR.

Produce, two tons and a half, eddiſh 9s. .	8	14	0
Profit .	5	13	6
In favour of the drilled	0	13	6
	£. 6	7	0

4th. WHEAT.

Drilled Acre. DR.

		£.	s.	d.
1791.				
Oct. 1,	Ploughing land . .	0	5	0
	Four harrowings and one rolling . . .	0	2	6
	Drilling ſeed 2½ by 9 inches	0	0	6
	Harrowing ditto . .	0	0	6
1792.				
	Seed, eight pecks, at 1s. 6d.	0	12	0
April 17,	Harrowing and rolling firſt time . . .	0	1	0
28,	Hoeing firſt time .	0	2	0
May 2,	Hand-weeding rows .	0	1	6
	Carried forward,	£. 1	5	0

Broadcaſt Acre. DR.

		£.	s.	d.
1791.				
Oct. 4,	Ploughing land . .	0	5	0
	Seed, eight pecks, 1s. 6d.	0	12	0
	Sowing ditto . .	0	0	6
	Harrowing ditto ſix times	0	3	0
1792.				
April 19,	Ditto and rolling firſt time . . .	0	1	0
May 14,	Weeding firſt time .	0	3	0
28,	Ditto ſecond ditto .	0	2	0
	Rent one year, &c. .	1	1	0
	Expences .	£. 2	7	6

Contra.

never upon an average lefs than from twelve to fourteen fhillings the acre annually in favour of the drill practice *.

The advantage of the drill method of fowing even for grain crops, feems therefore to be placed by thefe experiments in a point of view that muft tend to promote the practice; and for peafe, beans, turnips, potatoes, cabbages, vetches, and many fimilar crops, it has long been almoft generally confidered as the moft convenient and beneficial by thofe who have not fuppofed it adapted to grain.

But in refpect to an increafe in the produce on various defcriptions of foil, fuch as thofe of the loamy and mellow, as well as the cold, clayey, and more ftiff kinds, experiments which are afferted to have been made with much accuracy appear likewife from Mr. Cook's ftatements to be in favour of the drill fyftem †. This was found to be the cafe in Mr. Boote's practice, when extended

	£.	s.	d.
Brought forward	1	5	0
16, Hoeing the fecond time	0	1	0
20, Hand-weeding rows .	0	1	0
Rent one year, &c. .	1	1	0
Expences . £.	2	8	6

Contra.		CR.	
Sept. 14, Produce, thirty-fix bufhels, 6s.	10	16	0
Sheep feeding April .	0	3	0
Profit . £.	8	10	6

Contra.		CR.	
	£.	s.	d.
Sept. 18. Produce, for thirty bufhels, 6s.	9	0	0
Sheep feeding April .	0	3	0
Profit . £.	6	15	6
Gain in favour of drilled acre	1	15	0
£.	8	11	6

* Amos on Drill Hufbandry, p. 126.

† The refults are the following:

WHEAT.

Drilled produce per acre.	B.	G.	Q.	*Broadcafted* produce per acre.	B.	G.	Q.
1786. On loamy foils - -	47	0	0				
Cold clay ditto - -	44	5	2	On adjoining land - - -	9	4	2
Ditto - - - - -	25	1	3				

BARLEY.

On light land - - -	72	4	0				
Very light fandy land	41	0	0	On fame fort of land - - -	37	0	4

WHEAT.

to more than three hundred and ſixty acres, as well as in that of many other cultivators *. Since the reſults of theſe trials were taken, the various improvements that have been made both in the machinery for the purpoſe of drilling the crops, and thoſe for hoeing and keeping them clean afterwards, muſt probably have contributed to render the differences in the quantities of produce under the different methods of ſowing ſtill more conſiderable.

The practical ſtatements of a later experienced drill cultivator may, probably, on theſe accounts, be more ſatisfactory, and afford a more correct view of the ſuperiority of the practice. The writer, after a ſlight trial with another drill machine, and becoming more acquainted with the nature of the drill culture from a more extenſive obſervation of it in different places, determined upon making uſe of Mr. Cook's machine, and the method of management which he has recommended. He began by drilling in November, 1791, two acres and a half of light, dry, loamy, land, not worth more than twelve ſhillings the acre, middling barley ſoil, broken up from the ſtate of a foul, poor, pea ſtubble, with red lammas wheat, at the rate of one buſhel to the acre, in rows with nine-inch intervals; another part of the field, confeſſedly better by five or ſix ſhillings the acre, being ſown at the rate of two buſhels to the acre in the broadcaſt method, and managed in the beſt manner of that practice. The crop of the broadcaſt ſowing was, on account of the thinneſs of that of the drilled, it is ſaid, much ſuperior in its appearance during the winter and the early part of ſpring; but the other after being ſcarified once in March, and horſe-hoed the laſt week in May, exhibited a decided ſuperiority, the broadcaſt declining conſiderably; and that on the crops being reaped, that part under the drill

WHEAT.

Drilled produce per acre.	B.	G.	Q.	*Broadcaſted* produce per acre.	B.	G.	Q.
1787. On flinty loam in clover ley one earth	25	1	0	On ſame ſort of land	20	3	0
Ditto two years clover ley	27	2	0	On ſame ſort of land	25	0	0
Poor cold clayey after clover	25	4	0	On ſame land adjoining	13	7	0

BARLEY.

On flinty loam after wheat	27	0	0	On the ſame land	22	0	0

The ſame ſuperiority in the quantity of produce is evident in various other ſtatements, both with regard to wheat, barley, oats, beans, and peas; but the nature of the ſoil is either not diſtinctly mentioned, or there is not a clear compariſon made between the two methods of putting in the crops.

* Rev. Mr. Cook, in Memoirs of Bath Agricultural Society, vol. IV. p. 326.

ſyſtem afforded nineteen buſhels three pecks on the acre; while the part managed in the broadcaſt method did not produce quite five buſhels on the ſame extent of land.

And in a ſecond experiment on one acre of *potatoe fallow*, of the annual value of about twenty ſhillings, prepared by being once ploughed and harrowed, and ſown in March in the drill mode, with one buſhel of white lammas wheat; the plants when in double leaf being once ſcarified, and immediately afterwards harrowed acroſs with a common harrow, and after attaining the height of ſix or eight inches horſe-hoed, the crop had alſo the appearance of being thin and ſlight till after midſummer; but the produce, on being reaped, both in grain and ſtraw, was, notwithſtanding, very conſiderable, being twenty-nine buſhes three pecks, nine-gallon meaſure.

In the ſpring of the ſame year, thirty acres of land of the value of from thirty-five to forty ſhillings the acre, were tilled, manured, and prepared in every way in a ſimilar manner; fifteen acres of which being drilled in rows at nine inches, with two buſhels of ſeed to the acre, and fifteen acres broadcaſted, with from three to four buſhels the acre. During the growth of the crop, and at the time of cutting it, the ſeaſon was extremely wet. The crop put in, in the latter method, was lodged, ſtained, and ſecured with great difficulty; while that in the former was ſcarcely lodged at all, and being clear from weeds was houſed without injury, at half the extra expence of the other. The produce of grain was from ten to fifteen buſhels the acre more in quantity and one ſhilling the buſhel better in quality, although the broadcaſt crop had the advantage of being the firſt ſown, which was a point upon which much depended that ſeaſon.

And in a concluding experiment, a field of ten acres tilled, manured, and prepared for wheat, in every reſpect in a ſimilar manner, except that half was drilled with one half the above proportion of ſeed at nine-inch intervals, and the other ſown broadcaſt, doubts being entertained of the value of the land in different parts, two twelve-furrow ridges were, by way of proof, gathered through the middle of the part intended for drilling, the row ſowing being commenced on each ſide of them. The two ridges were managed, both in reſpect to ploughing, ſowing, and being weeded, in the manner of the common huſbandry of the diſtrict. The drilled crop had one ſcarifying and horſe-hoeing. At the period of harveſt, the two ridges were firſt cut; and immediately afterwards a breadth equal to one of them, of the drilled, was cut on each ſide, and each part ſecured and kept ſeparate till in a proper condition to be thraſhed, when they were carted into different barns, thraſhed out and winnowed; the drilled crop affording twenty nine buſhels three pecks, and the

broadcaſt twenty buſhels one peck. And that the experiment might be conducted with as much accuracy as poſſible, the ſame perſon was employed to winnow and meaſure the whole *.

Theſe experiments appear to have been made with ſo much exactneſs, and in ſo judicious a manner, that there can be little doubt of the reſults; and they have preſented ſo favourable an idea of the practice to the writer, that he aſſures us he has ever ſince followed it for the whole of his crops, repeatedly ſowing a part broadcaſt by way of proof; but that he has never once among all his trials ſeen the broadcaſt ſowing equal the drilled part.

There is another point in which the ſuperiority of the drill method of ſowing is ſaid to have a conſiderable ſuperiority, which is in the ſaving of ſeed; but it is probable that in this way the advantages cannot, in general, be ſo great as the ſtatements of cultivators under particular circumſtances of ſoil and ſituation have made them †. This would ſeem to be the caſe, from the obſervation

* Exter in Memoirs of the Bath Agricultural Society, vol IX. p. 23.

† The Rev. H. J. Cloſe ſtates the differences in expence, thus:

SEED-CORN.—*Expence on 131 Acres of Arable Land, in improved Drill-Huſbandry.*

	Acres.	£.	s.	d.
1799.	31 of Wheat, 3 pecks of ſeed per acre, at 8s. per buſhel	8	2	9
	26 Early white peas, 3 pecks per acre, at 8s. per buſhel	7	16	0
	18 Dun peas, 1 buſhel per acre, at 5s. 3d. per buſhel	4	14	6
	15 Tick beans, 3 pecks per acre, at 5s. per buſhel	2	16	3
	6 Early maz. beans, 3 pecks per acre, at 6s. per buſhel	1	7	0
	12 Oats, 1 buſhel per acre, at 3s. per buſhel	1	16	0
	13 Barley, 1 buſhel per acre, at 3s. 6d. per buſhel	2	5	6
	12 Vetches, 1½ buſhel per acre, at 6s. per buſhel	5	8	0
	Total	£. 34	6	0

SEED-CORN.—*Expence on 131 Acres of Land, in Broadcaſt-Huſbandry.*

	Acres.	£.	s.	d.
1799.	31 Of wheat, 3 buſhels per acre, at 7s. per buſhel	32	11	0
	26 Early peas, 4 buſhels per acre, at 8s. per buſhel	41	12	0
	18 Dun peas, 4 buſhels per acre, at 5s. 3d. per buſhel	18	18	0
	15 Tick beans, 3 buſhels of ſeed per acre, at 5s. per buſhel	11	5	0
	6 Early maz. beans, 3 buſhels per acre, at 6s. per buſhel	5	8	0
	12 Oats, 4 buſhels per acre, at 3s. per buſhel	7	4	0
	13 Barley, 3 buſhels per acre, at 3s. 6d. per buſhel	6	16	6
	12 Vetches, 3 buſhels per acre, at 6s. per buſhel	10	16	0
	Total	£. 134	10	6

Seed

ſo frequently made that thoſe engaged in this method of practice generally continue to increaſe the quantity of ſeed in almoſt all deſcriptions of crops, and on moſt ſorts of ſoil *. The great differences in the details of expence under the different methods, as given by the very intelligent practical agricultor juſt mentioned, ſhew, however, that much advantage may be derived in this way, where a correct attention is beſtowed in the management. On the exactneſs of this it is probable, however, that much of ſuch ſavings muſt depend.

There is reaſon to ſuppoſe that ſome proportions of ſeed may be more advantageous than others in regard to the quantity of produce, as it is obvious that injury muſt be ſuſtained from crops being either too thin, or too much crowded together upon the ground. Few experiments have hitherto, indeed, been made with a view to the aſcertaining of this matter † ; but the reſults of the few trials that have been attempted, ſeem to ſpeak in favour of the drill method of only a middling proportion ‡.

	£.	s.	d.
Seed in the broadcaſt huſbandry . .	134	10	6
In the drill huſbandry . . .	34	6	0
Saving in the ſeed-corn . £.	100	4	6

This it is added is the exact amount of the quantity of ſeed uſed on 131 acres of arable land the ſame year, and of the proportion of ſeed other farmers would have employed on the ſame quantity of land. The ſavings in this mode might, he thinks, be about 8,000,000 buſhels of wheat, 3,000,000 buſhels of barley, 1,000,000 buſhels of rye, 4,000,000 buſhels of oats, and 1,000,000 buſhels of beans and peas, which are yearly thrown away in ſeed-corn, independent of the additional produce which by the new ſyſtem might be obtained.—Theſe calculations cannot, it is obſerved, be ſuppoſed to be accurate, but the writer hopes the aggregate would not be very erroneous.

* Young's Annals of Agriculture.

† In Mr. Boote's experiments made in 1787, by drilling different grain crops, the reſults were, according to Mr. Cook, the following, on different ſorts of ſoil:

Quantity of Seed.	*Crop.*	*Soil.*	*Produce per Acre.*
4 Gallons . .	Wheat . .	On loamy after beans . .	45 buſhels.
6 Ditto . .	Ditto . .	On poor clay after clover . .	25 buſhels, 4 gal.
6 Gallons . .	Barley . .	On loamy land after turnips .	75 buſhels.
5 Ditto . .	Ditto . .	On ſandy land ditto . .	58 buſhels.
5 Gallons . .	Oats . .	On ditto after barley . .	57 buſhels.
3 Ditto . .	Ditto . .	On loamy land after barley .	76 buſhels.

‡ Cook in Memoirs of the Bath Agricultural Society, vol. IV. p. 328.

Numerous experiments have been defcribed by writers on hufbandry, in which the drill method has been fhewn to be greatly fuperior to that of the broadcaft for various forts of luxuriant vegetable crops, fuch as peas, beans, potatoes, cabbages, and even turnips in moft cafes. It has been obferved by an attentive drill cultivator, that beans, when drilled in two rows, at nine inches, with an interval of twenty-feven, if weeded fufficiently early, and well ploughed between, become quite thick and abundantly productive. And, in planting a coarfe piece of poor land in two different ways with potatoes, the one part in the common lazy-bed manner, and the other in drills of two rows at a foot afunder, and three-feet intervals between, for the purpofe of being wrought by the common plough, and which were three times ploughed and once hand-hoed during the time the crop was in the ground; it was found, on the crops being taken up, that the part fet in drills was by much the beft, notwithftanding it had been planted with only about two thirds the quantity of feed. And it is afferted that, in the fowing of turnips by means of the drill, befides their being better, there is a faving of four fhillings the acre in the after-culture of the crop, when drilled at twelve inches apart, and an opportunity afforded of performing the bufinefs in a much more effectual manner *.

And the experiments of another cultivator of this ufeful root feem alfo to fhew that a greater weight of produce may be obtained by fowing in drills on one-bout ridges, at twenty-feven inches diftance, than in the broadcaft method, or even in drills, on a level furface, at twenty-one inches †.

In regard to the practice of dibbling, though it may, as has been already obferved, in particular cafes and circumftances of foil and preparation, when correctly performed, have a degree of fuperiority over the broadcaft method, from the circumftance of more air and moifture being admitted to the plants, and, where the cuftom of hoeing prevails, from the foil being more fully ftirred; yet, from the expence and difficulty that attend it, and its being conftantly liable to be performed in an improper manner, it would feem to be not only lefs advantageous than the drill method, but lefs capable of being generally applied.

But whatever may be the advantages of particular methods of fowing, or in whatever manner the crops may be put into the foil, it will conftantly be neceffary to attend to their being kept as perfectly clean and free from weeds as poffible by fome means or other; as it is utterly impoffible, from the clofenefs and

* Exter in Memoirs of Bath Society, vol. IX.

† Jobfon in Communications to the Board of Agriculture, vol. II.

the want of free admiſſion of air, as well as the great conſumption of nouriſhment that muſt be daily drawn from the ſoil, in caſes where ſuch a number and variety of plants are ſuffered to vegetate together, that there can be abundant crops of grain if the buſineſs of eradicating them be either wholly neglected or only performed in a partial manner. Where the mode of putting in the ſeed will admit of it, care ſhould be taken to have the intervals, or portions of ground between the rows, as frequently ſtirred as may be ſufficient for affording the moſt full and perfect vegetation and ripening of the crops.

In the broadcaſt huſbandry, from the plants ſtanding in an irregular manner, the buſineſs of weeding and cleaning can only be performed by the hand with implements of either the forceps or hand-hoe kinds. But where the drill ſyſtem, or that of dibbling, prevails, as there is more regularity in the ſtate of the crops, this may be executed in other ways, and in a more eaſy, expeditious, and effectual manner, by the uſe of horſe-hoes, or other powerful implements of the ſame kind, drawn by horſes.

Hoeing.—This is a proceſs in which the ſoils, by being frequently ſtirred, broken down, and divided, while the crops are growing upon them, are rendered not only more ſuitable for affording ſuch ſupplies of nouriſhment as may be neceſſary, but for providing and continuing that fine ſtate or condition of the mould which is moſt adapted to their perfect growth. It is therefore, perhaps, one of the moſt uſeful and important operations in the practice of drill huſbandry, and one that ſhould never be neglected by thoſe who are engaged in that ſort of cultivation. It is a practice in which various advantageous changes are produced; the weeds that are injurious to the crops, are not only effectually eradicated and deſtroyed, but more abundant and more regular contributions of nouriſhment provided by the different new combinations of air, moiſture, or other matters that muſt take place either within or upon the ſoil, in conſequence of the mold being often turned over: and the crops, by being thus left in a clean and free ſituation, become more vigorous and healthy in their growth. The pulveriſation thus effected, likewiſe leaves the lands in a more open and permeable condition for the reception of the rains and dews into their internal parts; and the fibrous roots of the plants are not ſo liable to be injured by the drying and cracking of the earth about them during hot ſeaſons. There is alſo another effect produced by hoeing, that, in many caſes, may be of great importance; which is, that, by throwing up the mold againſt the ſtems of the plants in the ſpring months, a great increaſe in the crops may be accompliſhed by the

tillering or ſhooting out of new ſtems from the joints about the ſurface that are thus covered with earth, as happens in tranſplanting, and which has been well repreſented by a late ingenious writer *. Beſides, the land thus undergoes conſiderable preparation, and becomes in a more proper and ſuitable condition for the reception of ſucceeding crops†. It is alſo extremely obvious that, in proportion as ſoils are kept in a looſe, mellow, and pulveriſed ſtate, they muſt be more readily and more fully imbued with the various matters that may fall upon them. Thus the different ſubſtances that are precipitated, or come in contact with them, from the ſurrounding atmoſphere, ſuch as rain, ſnow, dew, air, &c. become more intimately and more abundantly blended, incorporated, and combined with each other and with the mold, in ſuch ſoils as are frequently ſtirred and rendered light and open by hoeing, than where they are ſuffered, by neglecting this proceſs, to become hard, compact, and almoſt impenetrable. In ſuch ſituations as where the ridges are high, they ſeldom, indeed, penetrate much below the ſurface, being too readily carried away by the effects of the ſun and wind, from their ſtagnating there, and becoming much expoſed to them.

From the great differences in the nature of ſoils, it is probable, however, that the proceſs ſhould be conducted ſomewhat differently. On the ſtiff, heavy, and loamy kinds of land, or ſuch as are much inclined to throw up weeds, it may be more frequently neceſſary than on ſuch as are light, thin, or ſandy; as in the latter, eſpecially in hot weather, much injury may be ſuſtained by a too frequent expoſure of the internal parts to the action of the ſun and air, by the great exhalation of their moiſture, and other beneficial properties.

It has been obſerved by a practical writer, that the land for the purpoſe of hoeing ſhould neither be in too dry nor too moiſt a ſituation, but in a middling condition, between theſe different extremes. But that on light and dry mellow ſoils the operation may be well performed at almoſt any time; while on the wet and ſtiff ones it can only be done to advantage in ſuch ſeaſons as render them the moſt ready to break and fall down into ſmall particles: as if done when moiſt in any conſiderable degree, much injury inſtead of benefit may be produced‡. It may, indeed, be remarked, that on the ſandy, gravelly, and all ſuch ſoils as admit the moiſture to readily filtrate and paſs away through them, there can ſeldom or ever be any neceſſity for delaying the proceſs of hoeing on account of the wetneſs of the land; though, in other caſes, it is obvious that

* Darwin's Phytologia.

† Tull's Horſe-hoeing Huſbandry, ch. ix.; and ſection on Fallowing of Land.

‡ Amos on Drill Huſbandry.

much attention muſt be paid to the ſituation of the ground, in this reſpect, before the operation be undertaken.

In reſpect to the methods of performing the work, it was adviſed, by the more early cultivators in this way, and while the large ſpaces were employed, to hoe or turn the ſoil from the rows or ridges on which the plants grow in the firſt operation, and by thus forming a ſmall ridge in the interval, to leave ſlight furrows or channels for the reception of the moiſture and other matters of the atmoſphere on the ſides of the rows of plants, thereby expoſing a large extent of ſurface to the action of the air. And it was conceived ſcarcely poſſible to perform the operation too deep, or come too near the rows of plants, ſo that they were not cut or rooted up; as by thus baring, and nearly expoſing, the roots, no injury was ſuppoſed to be done. And it was further imagined that, in particular caſes, as in expoſed level ſituations, the little ridglets, by being thus raiſed, might afford ſhelter and protection to the rows of plants, and by keeping the roots freer from moiſture, be leſs obnoxious to the effects of the froſts.

It would ſeem, however, to be a better practice, and more conformable to that of garden culture, by which plants are made to grow in the moſt perfect and luxuriant manner, to turn the earth up to the plants during the ſeverity of ſuch ſeaſons, and thus more ſafely prevent the effects of high degrees of cold or froſt upon them. As it is obvious that, by leaving little mold about their roots in the lighter deſcriptions of ſoil, they muſt be conſtantly expoſed to danger from the crumbling down of what remains in the winter ſeaſon; and, on thoſe of a ſtiff quality, by the little channels being formed ſo near them, injury may be apprehended from the ſtagnation of moiſture, and the great degrees of cold produced in conſequence of it. In the ſpring thoſe ridges, that had been formed in the middle of the intervals or ſpaces, were ſplit up and turned back again to the plants, which, from the mellowneſs of the mold, produced by the action of the froſts upon them for ſuch a length of time, was believed to afford more nouriſhment and ſupport to the crops. The ſame ſtate of mellowneſs and pulveriſation may, in moſt ſorts of ſoil, however, be effected without the riſk of expoſing the roots to danger, by a more frequent ſtirring of the ſoil, without forming ridglets in the intervals, ſo as to draw it away from the rows of the crops. And, in addition, there may alſo in this way be injury from the breaking and dividing the fibres and ſmall roots of the plants, the growth of the crops being thereby much checked and retarded.

Though it is probable that much of the advantage of the operation of hoeing may depend upon its being performed exactly at thoſe periods in which the crops firſt begin to decline, and ſtand in need of aſſiſtance, no ſatisfactory experiments

have, perhaps, yet been made with a view to afcertain the appearances in different cafes with that degree of precifion which is neceffary to enable the cultivator to guard againft fuch effects by commencing his operations.

It would feem, however, that the autumnal hoeings fhould be accomplifhed at fufficiently early periods for the crops to become firmly eftablifhed in the foil againft the winter fets in, and the fpring ones fo performed as that the growth of weeds may be prevented, and a fine ftate of foil be provided for the coronal roots of the plants to fhoot into, as about March or April, according to circumftances. Thus, where wheat has been fown at fuch an early period as to admit of the foil being ftirred by the hoe in the autumnal feafon, it fhould, it is faid, conftantly be accomplifhed fome time before the winter frofts fet in; as when delayed too long at fuch periods, by the ground about the roots of the plants being in this way made light, they may thereby be more liable to be thrown out of the ground during the thaws or heavy rains in the winter.

But the fecond or fpring hoeings muft be executed at different periods, according to the wetnefs or drynefs of the foil, and the nature, appearances, and forwardnefs of the crops; but in general the more early they can be done after the frofts have difappeared the better; provided the ground is fufficiently firm to admit the animals employed in performing the operation, without poaching the land and producing injury in that way.

The different after-hoeings muft conftantly be regulated by the particular circumftances of the foil and crops, and the judgment of the agricultor, both in regard to the moft proper periods for the performance of the bufinefs, and the frequency of their being repeated. Three or four may, in general, be fufficient, where proper care has been taken in preparing the land. It fhould, however, be conftantly kept in view, that the vegetation of the weeds be never permitted to advance too far, fo as, in any degree, to exhauft the land, or injure the crop, by their luxuriance and fhade; nor the furface of the ground become too firm and hard, fo as to impede the action of the dews, and the influence of the atmofphere; as, in particular foils, and very dry feafons, much injury may be fuftained in thefe ways from the crops not being perfectly fed. And in this laft intention it may even, in fome cafes, as where the foil has been confiderably impoverifhed, be neceffary to give a further ftirring to the land at an advanced period, in order to fupply frefh nourifhment to bring them to perfection.

On ftrong and wet foils it may, in many cafes, be likewife hazardous to delay the firft or autumnal hoeing too long, on the grounds, that fuch lands may become too poachy and wet to work in a perfect manner.

Light harrowing and rolling may alfo frequently be practifed with confiderable

advantage in breaking down and reducing the lumpinefs of the mold before the bufinefs of fpring hoeing is begun; but thefe operations muft be directed by the judgment of the cultivator.

This fort of bufinefs muft be performed in different methods, according to the particular circumftances of the crops. For grain or fmall feed crops, where drilled or fet with narrow intervals or fpaces, the operation of hoeing fhould be performed with hand-hoes, or fuch implements of the horfe-hoe kind as have fhares adapted to the diftances between the rows. But for pulfe crops of different kinds, and all fuch plants as are fown or fet in rows with fpaces of confiderable extent, implements of larger dimenfions and of greater ftrength may be more effectual.

The introduction of the ufe of the hand-hoe for the ftirring of the earth between the rows of fuch crops as were drilled or fet at narrow diftances, as from fix or feven to nine or ten inches according to the kinds of crop, was for fome time confidered as a great improvement upon Mr. Tull's method of drilling or fetting two rows near together, and leaving wide intervals of two or three feet between the different nearly-planted rows, for the purpofe of being hoed with horfe-hoes. The hand-hoes employed for narrow diftances by an attentive and able agricultor*, in wheat and pea crops, are faid to be about fix inches wide, and thofe for barley about four. And, with implements of this kind, the fuperficial parts of the foil between the rows of grain are not only effectually turned over, and the weeds eradicated, but their growth prevented by the mold being heaped againft the rifing ftems of the plants †.

The hand method has, however, by many ingenious cultivators, lately given way to that of hoeing feveral rows at a time, by means of horfe-hoes contrived for the purpofe; a method which is certainly lefs expenfive, and much more expeditious, and in which the paffage of the horfe amongft the plants, where that is neceffary, is faid to be of no material injury or inconvenience.

The advantage of this method over that of the hand-hoe muft evidently be confiderable from its much greater power in loofening the foil, and paffing to a much greater depth, as well as in doing the work in a more regular and complete manner ‡.

* Mr. Coke, Holkom, Norfolk. † Darwin's Phytologia, p. 438.

‡ The fuperiority of the method of hoeing by means of horfes, over that by manual labour, will probably be placed in a more clear point of view by the details of the comparative experiments that have been made by an able writer on drill hufbandry. In cultivating an acre of ground, which

HAND HOES.

Fig. 1.

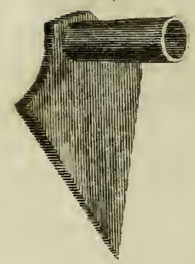


Fig. 7.

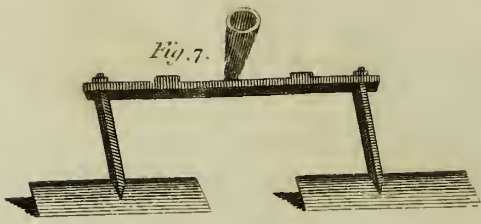


Fig. 4.

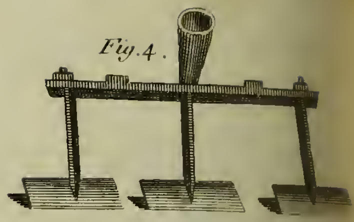


Fig. 3.

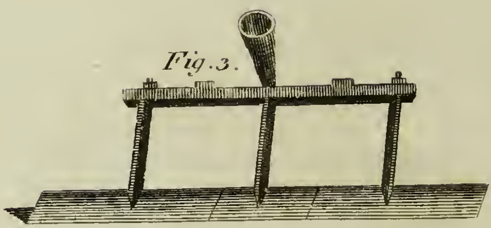


Fig. 6.

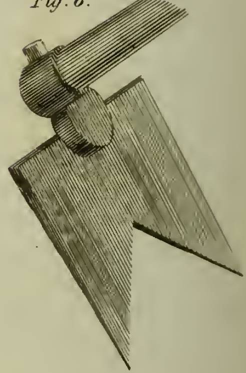


Fig. 5.

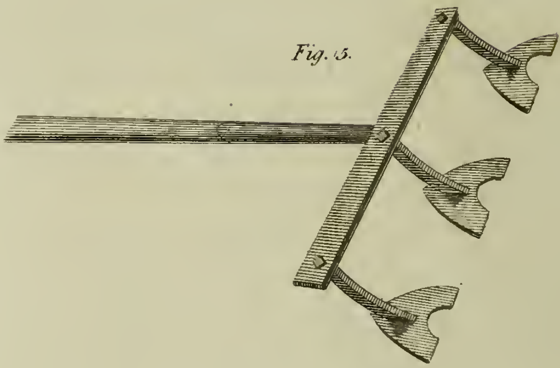


Fig. 2.

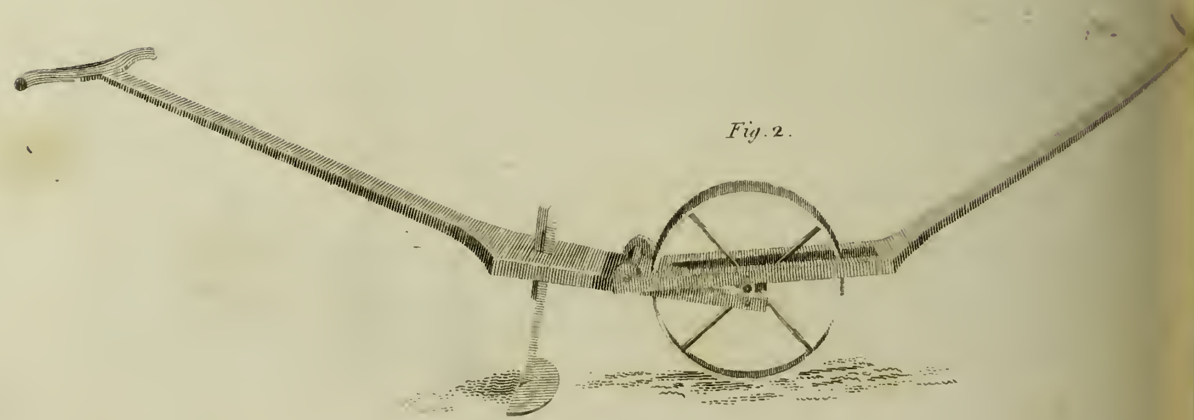


PLATE LI.

Hand Hoes.

[*To face Page* 502.]

Fig 1. Reprefents a *triangular hand-hoe*, which is found more ufeful in fome cafes than the common fquare hoe, efpecially in thinning out crops that ftand very thick or clofe together.

Fig. 2. Is the reprefentation of a treble hoe invented by Mr. Ducket, by which three rows are finifhed at a time, the perfon ufing it *advancing* in the common way. It weighs with the three hart-hoes 7lb. 9oz., and is capable of being ufed by a woman accuftomed to the work. It is much more effectual in producing a fine tilth in the drills than the common hoe.

Fig. 3. Is another treble hoe for making drills, the fhares being fet for drawing, the operator going backwards; and in order to have more preffure without tiring the wrift, a rope is added, which, paffing round the operator's body, draws from that place where the hand would have acted: the weight with two twelve-inch hoes is 7lb. 3oz.

Fig. 4. Shows the hoes as employed in making trenches in gardens, for the reception of manure in planting potatoes; which are formed very expeditioufly by ftriking in a line; bringing the mould up into a half ridge, and then finifhing it by turning and going back. It weighs with three ftraight fix-inch hoes 6lb. 11oz.

Fig. 5. Exhibits the two outward hoes, a fpace being left in the middle for hoeing on each fide a drill of any fort of plants with fafety.

Fig. 6. Reprefents a hand-hoe employed in Portugal with much effect in hoeing the declivities and fteep fides of the hills, as well as in other fituations. It is recommended as a very effective tool by Lord Somerville in his Syftem of the Board of Agriculture.

Fig. 7. Is the reprefentation of a hoe invented by Mr. Macdougle, which is drawn by a man before and directed by another behind; and is a very ufeful tool for hoeing crops that ftand at fufficient diftances in the rows.

But where the proceſs of hand-hoeing is in uſe, which we have ſeen to be often the caſe in diſtricts where the drilling or dibbling of grain in rows at narrow diſtances is practiſed, various implements of the ſmall hoe kind are employed. The old light ſquare form of hand-hoe has now, in moſt caſes of field huſbandry, given way to thoſe of a more weighty and effective conſtruction, by which the buſineſs of hoeing, eſpecially in light ſoils, is not only more quickly

was a light ſandy loam, of the annual value of about twenty ſhillings, under a potatoe crop, in the different methods, the reſults were found to be as follow:

Horſe-hoed Acre.		DR.		
1789.		£.	*s.*	*d.*
Feb.	2, Ploughing firſt time -	0	5	0
	28, Harrowing - -	0	0	6
	Dung, twelve loads, and ſpreading - -	0	16	0
March	1, Ploughing ſecond time -	0	4	0
April	2, Harrowing ditto - -	0	0	6
	24, Ploughing with 3 ploughs	0	4	0
	Planting 12 hands 3 inches deep, 9 aſunder, with 30-inch alleys -	0	4	0
	Seed and cutting; 30 buſhels at 1s. 4d. -	2	0	0
	Rolling - -	0	0	6
June	1, Harrowing for 1ſt hoeing	0	0	6
	10, Skim-hoeing firſt time -	0	1	0
	Hand-hoeing the rows -	0	3	0
	26, Skim ditto, ſecond time -	0	1	0
	Hand ditto rows - -	0	3	6
July	1-15, Earthing up rows twice -	0	2	0
Aug.	2, Picking out weeds -	0	1	6
Oct.	20, Taking up, pying, &c. -	1	16	0
	Expences -	6	3	0
Contra.		CR.		
	Produce, 500 buſhels, at 8d. - - - -	16	13	4
	Profit £.	10	10	4

Hand-hoed Acre.		DR.		
1789.		£.	*s.*	*d.*
Jan.	12, Ploughing firſt time -	0	5	0
Feb.	24, Drag-harrowing -	0	1	0
	Dung, twelve loads, half charged, ſpreading, &c.	0	16	0
Mar.	2, Ploughing ſecond time	0	4	0
	30, Harrowing twice - -	0	1	0
April	24, Ploughing with 3 ploughs	0	4	0
	Planting 12 hands 3 inches deep, 8 aſunder, 24-in. alleys - - -	0	4	6
	Seed and cutting, thirty-ſix buſhels at 1s. 4d. -	2	8	0
June	1, Harrowing for firſt hoeing	0	0	6
	14, Hand-hoeing firſt time -	0	5	0
	26, Second ditto - -	0	4	0
July	6, Earthing up - -	0	15	0
Aug.	3, Picking weeds - -	0	1	6
	Taking up, leading, pying, &c. - -	1	14	0
	Expences -	7	3	6
Contra.		CR.		
	Produce, 420 buſhels at 8d. - - -	14	0	0
	Profit	6	16	6
	Advantage in favour of horſe-hoed acre -	3	13	10
	£.	10	10	4

And

and lefs expenfively performed, but the mold ftirred to a much greater depth. By attending to the above principles, and thofe of accomplifhing the operation on feveral rows at a time, an ingenious cultivator has lately contrived an ufeful tool of this fort, which hoes three rows at once, and is capable of being varied according to the purpofes for which it is employed *. In the firft form, a fine tilth is faid to be ftruck by it into drills for receiving any fort of feeds with much more readinefs than by the ordinary method of ftriking with the corner of the common fquare hoe, along any line of direction, as when one drill is cor-

And on an acre of ftiff hazle-coloured loamy foil, of about the fame annual value, under a cabbage crop, the refults of trials, conducted in the different methods, were thefe:

Horfe-hoed Acre.	£.	s.	d.
1790.	DR.		
Jan. 14, Ploughing - -	0	5	0
Feb. 20, Harrowing twice - -	0	1	0
Mar. 11, Dung, twelve loads, half charged, at 3s. -	0	18	0
14, Ploughing fecond time -	0	4	0
April 20, Drag - harrowing and couching - -	0	3	6
May 14, Ploughing into four-feet lands - - -	0	4	0
Five thoufand plants at 2s. 6d. - -	0	12	6
Planting 48 by 30 inches	0	8	6
June 10, Ploughing from rows -	0	2	6
Hand-hoeing and hilling	0	3	6
July 1, Ploughing to rows - -	0	2	6
20, Earthing up by horfe-hoe	0	1	6
Aug. 1, Hand-weeding and vermin killing - - -	0	1	6
Rent, &c. - -	1	1	0
	4	9	0
Contra.	CR.		
Dec. 21, Value of produce, 50 tons	10	0	0
Profit - £.	5	11	0

Hand-hoed Acre.	£.	s.	d.
1790.	DR.		
Jan. 15, Ploughing - -	0	5	0
Feb. 21, Harrowing twice -	0	1	0
Mar. 11, Dung - - - -	0	11	0
14, Ploughing fecond time -	0	4	6
April 20, Dragging, harrowing, and couching - -	0	4	0
May 14, Ploughing third time -	0	4	0
Plants, 5,500 - -	0	13	9
Planting 36 by 30 inches	0	10	6
June 10, Hand-hoeing and earthing up - - -	0	12	0
July 20, Ditto fecond time -	0	7	6
Aug. 1, Hand-weeding, &c. -	0	2	6
Rent - - -	1	1	0
	4	16	9
Contra.	CR.		
Dec. 21. Produce, 41 tons - -	8	4	0
Profit -	3	7	3
Advantage in favour of horfe-hoed acre -	2	3	9
£.	5	11	0

From the expeditious and effectual manner in which the operation is performed in this way, there can be little doubt but that it muft have an equal fuperiority in other forts of crops.

* Ducket, junior, in Communications to the Board of Agriculture, vol. II.

rectly opened, the reſt muſt, of neceſſity, be made with exactneſs. This is made uſe of in an advancing poſture; but it has another form which admits of its being drawn, the perſon uſing it moving backwards, the preſſure being aſſiſted by a rope or ſtrap paſſing from that part of the handle where the hand is applied, round the body of the labourer. The third is ſo contrived, that trenches for potatoes, or other ſimilar crops, can be readily made by it. It has likewiſe another mode of conſtruction, in which a ſpace is left in the middle, that allows of its paſſing on each ſide a row of any kind of plants with great facility, and without any danger of their being injured. Its conſtruction may, however, be better underſtood by the annexed plate. It is aſſerted that two acres of barley may be hoed in a day by means of this implement, and that good work may be made with it in oats and wheat *.

The breaſt-hoes have alſo been recommended, by ſome experienced agricultors, as more uſeful in hoeing grain crops ſown in rows at narrow diſtances, than thoſe of the common kind, from their performing the work in a more perfect and expeditious manner.

The triangular hand-hoe having the point of one of the angles downwards, has likewiſe been found of conſiderable utility in thinning and ſetting out crops, ſuch as turnips, whether ſown in the drill or broadcaſt method.

There are other kinds of hoes which are wrought by the hand, that may be employed for particular purpoſes, but which have been already mentioned †.

It has been remarked by a noble and intelligent promoter of agricultural improvements, in a late work ‡, that the Portugueſe, who conſiderably excel in the uſe of the hoe, have an implement of this ſort, which, by its weight and conical ſhape, and from its handle being light and ſhort, performs its work to a good depth, without requiring much exertion in the perſon that uſes it. They employ it in the breaking up of the ſtrong lands of their vineyards, which could not, it is ſuppoſed, be wrought by hoes conſtructed in the manner that our common ones are. Theſe principles have however been, in ſome degree, applied in the forming of the different ſorts of hand-hoes deſcribed above. It is alſo ſuggeſted, that this implement may be found extremely uſeful in the digging and cultivating of the land of ſteep mountainous diſtricts, as well as in the forming of compoſt manures of lime and earth in the corners of fields where the plough cannot be made to perform the buſineſs, and in very hilly ſituations, where the

* Ducket, junior, in Communications to the Board of Agriculture, vol. II.

† Section on Implements. ‡ Lord Somerville's Syſtem of the Board of Agriculture, p. 136.

ſpade cannot be eaſily employed. On head lands, in arable fields, and in orchards, or other plantations, for hand-digging it may likewiſe, it is ſuppoſed, be found of utility in different caſes *.

The implements that are had recourſe to where weeding the crops by hand-labour is practiſed, are very few, conſiſting principally of a ſort of forceps, or tongs, that act on the principle of the lever, having handles of two or three feet in length, by which they are made to take hold, and force up different ſtrong weeds, ſuch as docks and thiſtles, that cannot be otherwiſe handled ſo as to be drawn up and completely removed.

The prevention of the growth of ſeed weeds is attempted in different methods in different diſtricts; in ſome, as has been ſeen, by the expoſure of the ſoil to the action of the ſun during the hot ſummer months, every third or fourth year, according to the nature of the land, by frequently ploughing and expoſing new ſurfaces †; but in others by the alternate ſowing of grain, and what are termed green crops, and the ſtirring of the earth frequently well between the plants, by means of the hoe, while they are growing. The laſt is undoubtedly the beſt practice in all caſes where the nature of the land will admit of it, as there is no loſs from the land remaining, for a time, in an unproductive ſtate. It is remarked by a late writer, that, in the diſtrict which he deſcribes, on the *ſandy loams* this buſineſs is effected by hoeing the crops of peas, tares, and turnips. On the peas or tares being removed from the ground, the land is ploughed and harrowed, and the *root* weeds burnt, after being brought together by means of raking. And on the land thus freed from *root* weeds, turnips are ſown, and the *ſeed* weeds deſtroyed by repeated hoeing ‡. By a proper attention to the nature of crops, and the cultivation of them in rows, ſo as to admit of a full and effectual application of the hoe while they are upon the ground, it is probable that the growth of weeds may, in moſt caſes, be in a great meaſure prevented, without having recourſe to other more expenſive proceſſes. Even under the broadcaſt culture, a greater regard to the modes of cropping, and a more free and liberal uſe of the hand-hoe and the forceps, may have conſiderable effect in the prevention of the growth of weeds, and the injurious conſequences reſulting from them, as well as in keeping the soil in a more mellow and proper condition for the production of uſeful crops of all kinds.

The hand and breaſt-hoes being ſeldom ſufficiently effectual even on the lighteſt deſcription of ſoils, from their not performing the buſineſs to a ſufficient

* Lord Somerville's Syſtem of the Board of Agriculture, p. 156.

† Section on Fallowing of Land.

‡ Middleton's View of the Agriculture of Middleſex.

USEFUL HORSE HOE.

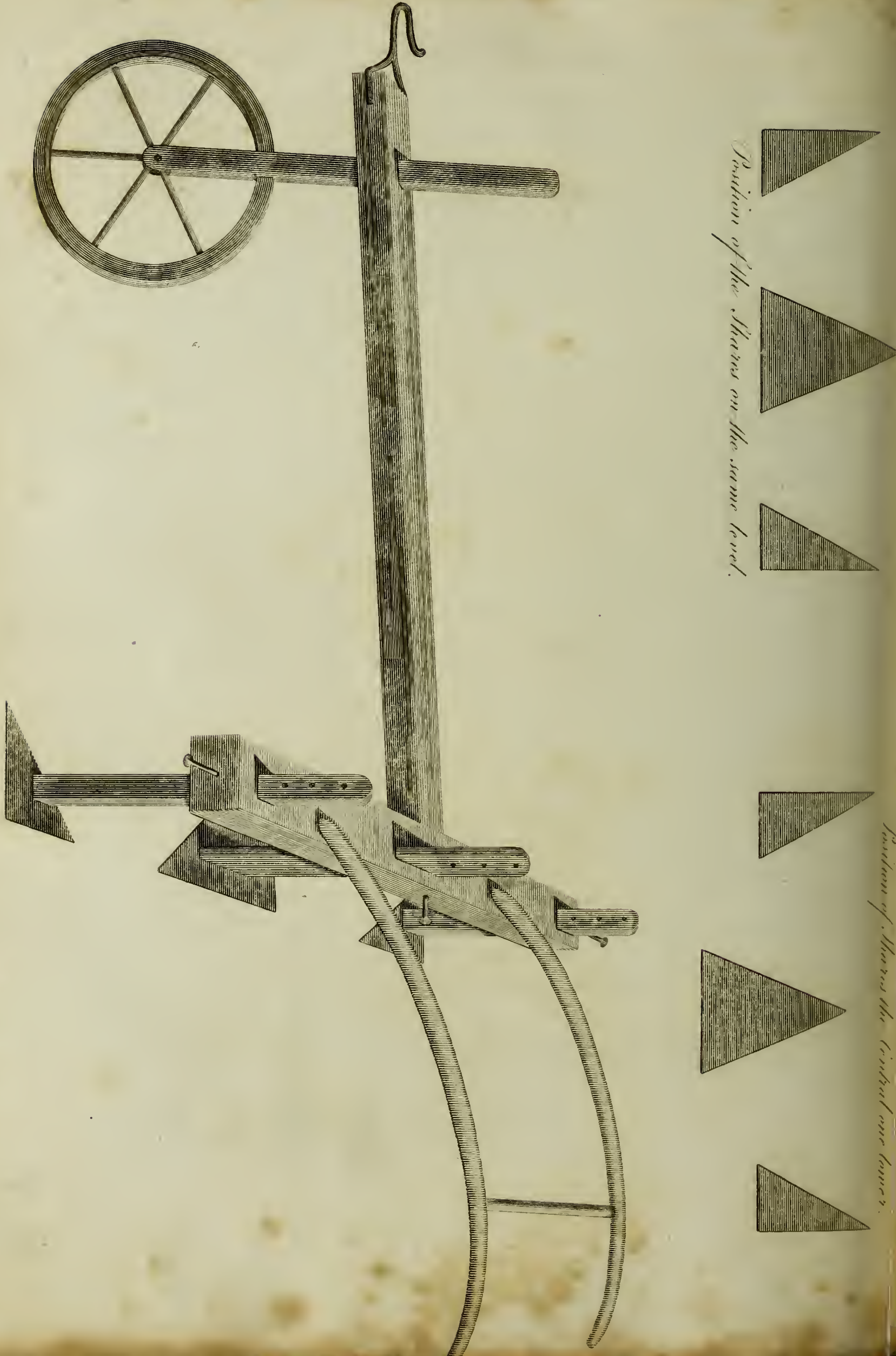


PLATE LII.

Useful Horse-Hoe.

[*To face Page* 504.]

THIS reprefents a *Horfe-Hoe* or *Shim* recommended by Mr. Young, the hint of which he took from the Berkfhire one, and to which the beam and block is capable of being applied. He has found it a very ufeful tool. In a wide interval, the three fhares may be worked on a level. Between the rows of cabbages, after earthing up, the two external fhares may be fet to cut the weeds that are apt to rife on the fides of the ridges, without difturbing too much earth, and the centre fhare funk to fcrape the bottom of the furrow. The centre one may alfo be worked alone between narrow rows. In forging the fhares of all Shims, Mr. Young well obferves, that the blackfmith fhould be careful to give them tendency enough *into* the ground, bending them downwards: for want of this caution he has found many of them to work badly; the wheel in the beam counteracts this tendency fufficiently.

depth, thofe of the horfe kind have become more general. Befides, thofe of the former fort being in every cafe difadvantageous in point of economy, from the circumftance of fo much more work being capable of being performed by thofe where horfes are employed, the latter are to be preferred in moft inftances where the nature of the foil and crop will admit of them.

Some fuppofe that the great fuperiority of the horfe-hoe is fhewn by the finenefs of the appearance of fuch crops as have been hoed in that way over thofe in which the hand method was employed; while, at the fame time, it demonftrates that deep and complete ftirring of the foil is in general to be preferred as the moft beneficial for perfecting the growth of the crops.

In the hoeing of fuch crops as are drilled at fmall diftances, the horfe-hoe annexed to Mr. Cook's drill machine is an extremely convenient and effective implement on almoft any foil.

And for narrow intervals and mellow foils, the *expanding horfe-hoe,* invented by Mr. Amos, and the *fix-fhared horfe-hoe,* may be found very ufeful and effective implements *. The former has much fuperiority in confequence of its expanding fhares, by which it can be fet to fuch diftances as may be required within the limits of twelve and thirty inches, and, of courfe, be capable of ftirring the ground in intervals of any diftance between fuch extremes †.

It has been found ufeful in hoeing bean crops, whether drilled or fown in equidiftant rows; and may likewife be applied in the hoeing of potatoe or cabbage crops, as it is capable of performing the bufinefs in a tolerably complete and expeditious manner.

The harrow which is attached to it may be ufeful in particular cafes, as where the land is difpofed to throw up fucceffive crops of weeds, and in the preparation of it for the reception of crops.

The fix-fhared horfe-hoe, from its being regulated in refpect to the rows, may alfo be made ufe of for grain crops where the diftance is but fmall, as nine inches. It may likewife be employed in the preparation of the more ftiff, gravelly, and ftony defcription of foils, or fuch as are infefted with weeds, by fubftituting the coulters in the places of the triangular hoes. The coulters being fo contrived as to cut and divide the upper parts of the earth at the fame time that the inferior parts are effectually ftirred.

But for performing the bufinefs, in particular cafes, the fame practical agricultor has recommended the ufe of a fmall *Rotheram plough,* or a common plough of any diftrict, made upon a fmall fcale, with a broad fharp fhare; on ftiff foils, where the nature of the crops will admit of wide intervals, he thinks fuch forts of ploughs

* Amos on Drill-hufbandry. † Section on Implements.

preferable to all other kinds of hoeing implements; as they can be made to go to any depth required, and be wrought very near the rows, at the expence of merely the labour of one horfe where the foil is of the light kind, and in a fine ftate of tillage. And another defcription of plough that may be of great utility in this bufinefs in earthing up the rows of plants on each fide at once, is that with two expanding mold-boards, as by this means much work can not only be expeditioufly performed, but the mold laid up to fuch heights as may be thought the moft advantageous to the plants.

But it is maintained by an able writer on rural economy, that all the different operations of the horfe-hoeing kind may be effected by means of the common *fwing-plough*, and in a much more complete and perfect manner, than by the affiftance of the hoe or double-mold-boarded plough, which is commonly made ufe of for this fort of bufinefs *. The procefs of horfe-hoeing, as defcribed and recommended by Tull, Chateauvieux, and other writers of the fame period, is, he thinks, objectionable on different grounds. From the earth in the firft operation being turned away and removed from the rows of the plants by the furrows being drawn on each fide of them, and turned towards the intervals, the roots of the plants muft be left naked and expofed on each fide at the fame time; and the narrow ftrips or ridglets on which they are placed, from being in this way rendered dry and hard by the powers of the fun and wind, be rendered lefs proper for the fupport of fuch plants, and confequently greatly retard and injure them in their growth, unlefs it be prevented by fuch other means as have a tendency to obviate the advantageous effects of the procefs, fuch as that of neither going in any degree fo near the rows of plants on either fide, or fo deep, as might otherwife be the cafe with fafety, but in fuch a manner as to leave a confiderable portion of earth for the roots of the plants to bed and extend themfelves in; and fo that there may be fufficient refiftance afforded by the ridglet on the left-hand fide of the plough, to enable it to turn up the neceffary parts of the folid earth on the right-hand fide; and further, that inftead of its going directly downwards near to the rows, be fo managed as to form the cut obliquely outwards, in order to guard againft the mouldering down of the earth from the upper parts, and leaving the roots of the plants expofed. Thefe combined circumftances render it clear, that a large proportion of the foil muft remain unftirred near to the place where the plants grow, and which, of courfe, can derive no advantage whatever from the procefs of hoeing.

The fecond procefs, or that of turning the earth back towards the rows, is ufually performed by a double-mold-boarded plough paffing down the middle be-

* Anderfon's Recreations in Agriculture, vol. II.

HORSE HOEING.

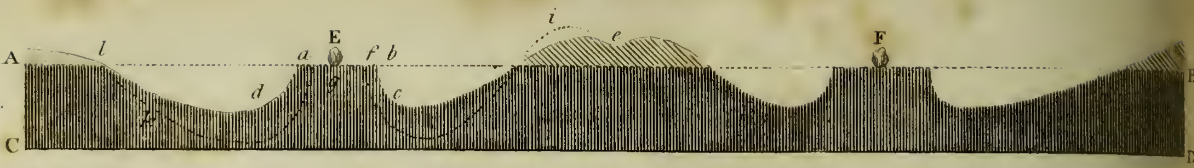


Fig. 1.

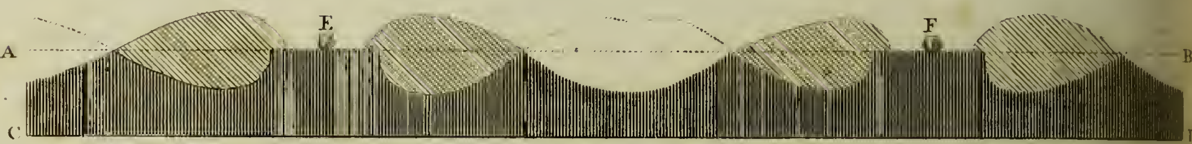


Fig. 2.

Fig. 3.

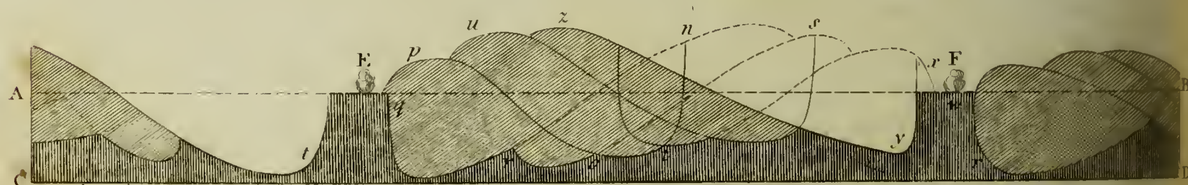
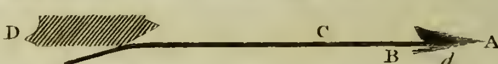


Fig. 4

Fig. 5.


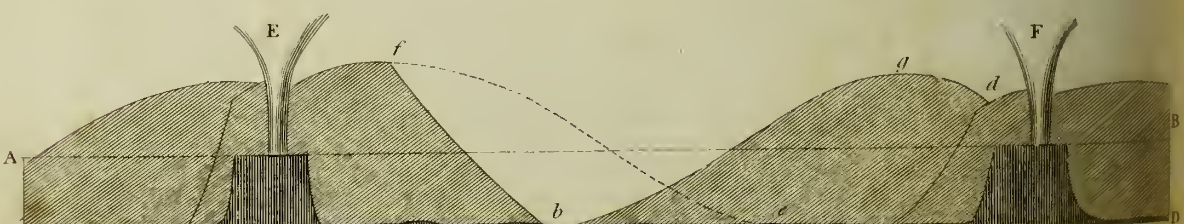


Fig. 6.

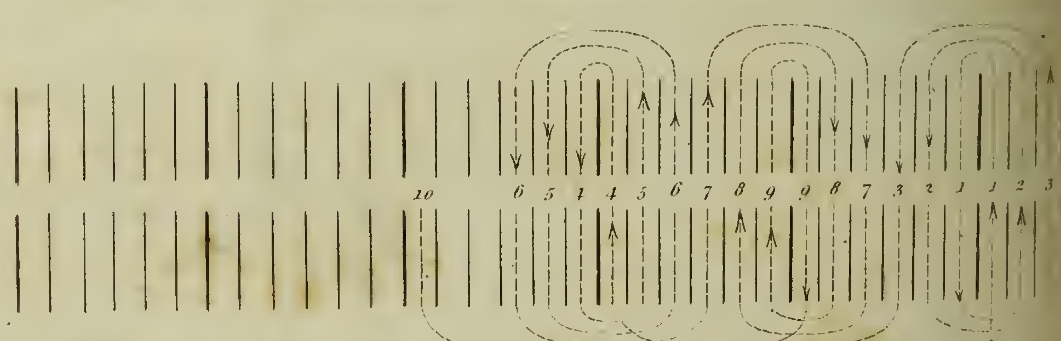


Fig. 7.

PLATE LIII.

Horfe-Hoeing.

[*To face Page* 507.]

In illuftration of the nature of horfe-hoeing by means of the fwing-plough, *Figs.* 1 and 2 reprefent the furface of a ploughed field, the lines AB, AB, and CD, CD the bottom of the ploughed part of the field, which is fix inches in depth; this being the whole of the bed in which the plants are to find their nourifhment. FF reprefents two rows of plants intended to be horfe-hoed, that are placed at three feet apart. At the firft operation the plough makes the furrow *b*, *c*, *e*, *Fig.* 1, turning the earth from the row of plants E; and returning on the other fide of the row makes the furrow *a d l*, leaving the row of plants E ftanding upon the eminence *d a b c*. The fame operation being performed on the row F, it is left as in the figure, and fo through the whole field The furrows in this cafe are reprefented as going to the depth of three inches, and the diftance *a b* is nine inches, and made to approach nearer to the row E on each fide, and to go perpendicularly downward, fo deep as to reach the bottom of the manured foil, as is reprefented by the dotted lines *f h i* and *g k l*. It is evident that the fmall pillar of loofe earth *f h g k*, deprived of all fupport on the oppofite fide, could not have refifted the preffure of the plough while it forced out the earth in the oppofite furrow; nor have ftood in this pofition, or retained moifture to preferve the plants alive.

Fig. 2. Reprefents the fame field as it is left after the fecond operation, in which the furrow made by the double-mould-board plough is reprefented as four inches deep (being eight inches perpendicular from the furface of the raifed up earth). Little of the mould can be actually removed by thefe operations, though repeated ever fo often; more than three-fourths of the vegetable mould remain untouched.

Fig. 3. Reprefents the fame field as before, with the rows of plants EF growing upon it. But inftead of beginning the firft hoeing, as before, by running the plough along the right-hand fide of the row E, go along the left-hand fide of it, fo as to lay the earth toward that row, as at *a b c*. Having performed this operation on the left-hand fide of the row E, and fuppofing the plough brought back to the fame end of the field, fuppofe it to begin between the rows E and F, by drawing the furrow marked *d e f* (the fpace between *d* and *g* being prefumed to be at this time folid mould), fo as to turn the earth toward the row F. Then (the plough being again brought back to the fame end as at firft) draw the furrow *h i k*, which, by having had an open furrow to the right-hand fide of it, can be with eafe made deeper than the former. Then, by going a third time in the fame direction, draw the furrow *g l m*; going in this cafe as clofe to the row as you pleafe, as the folid earth on the back of it prevents it from being deranged. In this way, by this firft operation, a much greater proportion of the mould is turned over than by the common procefs, as in *Fig.* 1; the black part of the figures in both cafes reprefenting the part of the mould that is left untouched.

Fig. 4. Reprefents the field after it has undergone the fecond hoeing; in which the dark parts reprefent the mould that has been left untouched. In this operation all the fteps of the laft hoeing are directly reverfed: inftead of beginning at the back of the row E, and, turning the furrow towards it, the plough begins on the right-hand fide of the row F, and going in an oppofite direction, turns the furrow towards the row F. That done, ftill holding the fame direction, it is made to pafs between the rows F and E, fo as to open the furrow *n o p* (the dotted line *q r n* reprefenting the open furrow that was left in the firft hoeing). A fecond furrow is then drawn in the fame direction, fo as to form the opening *s t u* (the dotted line *n s x* reprefenting the furface of the mould as left at the laft hoeing); and a third furrow, drawn in the fame direction, leaves the opening *x y z*; in which fituation it remains till the third hoeing commences.

Thus every inch of the mould, except perhaps the fmall bit *q t w r* under each row, will receive nearly as complete and thorough a fummer fallow as if no plant whatever had grown

5

upon the ground. Which if compared with *Fig.* 2, the difference between the merits of the two operations will be obvious. But if at the laſt hoeing the field had been left as repreſented by the dotted line *d e f*, *Fig.* 5. having the furrow turned toward the row F, and the earth ſtrongly laid up to the ſtems of the cabbages, the plough, when it is intended to finiſh off the operation, ſhould be introduced ſo as to turn the earth toward the row E. In that caſe, the operator, by inclining his plough a little to the left, makes it cut in an oblique direction, inſtead of perpendicularly, as he has hitherto invariably worked; and, ſtriking deep, ſo as to go quite to the bottom of the manured mould, he forms the opening *f h g*, ſo as to leave a clear opening in the middle, with the looſe earth cloſely laid up to each ſide.

Fig. 6. Shows the mode of returning the plough ſucceſſively to the ſame place without any loſs of labour, the black lines on which are intended to repreſent rows of plants of any kind, on a field regularly laid out for horſe-hoeing. Suppoſe the plough to ſtart at A, and, going right forward, it enters the field on the right hand ſide of the row marked B; and proceeding forward to the other end of the field, it opens a furrow, laying the earth from the row B toward the adjoining row to the right; then turning to the left hand, it returns on the other ſide the ſame row, laying the furrow from it on that ſide alſo. In this inſtance, the row B will be left preciſely in the ſame ſtate as every row is left after the firſt hoeing in the Tullian method. The plough proceeding forward to the end where it began, or the lower end of the field, it then turns to the left, and goes up the row 2, having the ſecond row (or that row toward which the earth moved by the laſt furrow was laid) on its left hand, ſo as to turn the earth from it on that ſide. Proceeding forward, it turns at the head toward the left hand again, and returns down the furrow 2, leaving that row in the ſame ſituation as the former. After the ſame manner proceed, widening always as you go round, and turning ſtill to the left, till the rows become ſo far aſunder as to make it inconvenient to turn longer in that direction. When you find it neceſſary to ſhift a new ridge on account of its width, being returned to the ſame end from which you began, count the number of furrows opened, multiply half that number by three; then, beginning from the point where you ſtand, ſet off as many intervals as make up the number you have found; and then mark the row where you ſtop. In the figure the ridge conſiſts of ſix rows; and as three is the half of ſix, and three times three make nine, it follows that, paſſing theſe nine intervals, you mark the tenth row, which falls on the row *c* marked on the figure. Move the plough then from where it ſtands, as marked by the dotted line and darts, and enter it on the interval on the right-hand ſide of the row C; proceed exactly as at firſt, till you open ſucceſſively the furrows 4, 5, and 6, both going and returning, as marked by the dotted lines and darts in the figure. There now remains a ſpace of ſix rows between 3 and 6, which is untouched. Turning the plough ſtill to the left, as before, open the furrow 7 going upward; but, inſtead of turning to the left at the top of the ridge, now turn to the right, and go down the furtheſt untouched interval, opening the furrow 7 on the return. At the bottom, turn ſtill to the right, and ſo again at the top, opening up ſucceſſively the furrows 8 and 9, where you cloſe, turning the earth on both ſides towards D, ſo as to leave it exactly in the ſame ſtate as a Tullian row would be left after the ſecond hoeing. The plough, when this is finiſhed, comes out at E, whence it may proceed to another. By beginning at A, and following the dotted lines in the direction of the darts, the progreſs may be regularly traced throughout the whole proceſs. Proceed regularly after the ſame manner till the whole field is gone over, and obſerve that every ſubſequent hoeing is performed by directly reverſing this; beginning always in the ſecond hoeing where the firſt left off, and leaving off where it began, making the plough go in a contrary direction; ſo as to begin at the bottom in the interval 9 on the right-hand ſide of the row D, and return downwards in the interval 9, and ſo on till the whole is completed.

This method is deſcribed and recommended by Dr. Anderſon.

tween the rows, ſo as to divide the ridglet equally, and throw up a part to each row. By this means the looſe mold that was turned from the rows in the preceding operation, is now returned back to them, together with a portion of the ſolid earth from the middle. It is, therefore, evident, that ſo ſmall a portion of the ſolid parts of the earth is ſtirred in this way in this part of the proceſs, that but little advantage can be gained by the crops in proportion to what might be the caſe by a more full, effectual, and complete ſtirring of the various parts of the ſoil. And as the whole of the buſineſs of this ſort of hoeing conſiſts in the mere repetition of one or other of the above operations, it muſt follow that much of the ground muſt be left unſtirred, and of courſe not pulveriſed or expoſed to the ameliorating influence of the atmoſphere, by which new and more abundant ſupplies of food may be prepared, and the growth and vigour of the plants be promoted in the moſt full and complete manner.

But in order to place the defects of this ſyſtem of horſe-hoeing in a ſtill more clear point of view, and to ſhew the ſuperiority of that by means of the common ſwing-plough, the ingenious author juſt mentioned has accompanied his deſcriptions of the different proceſſes with figures or repreſentations of the manner in which the hoeing is to be performed in each caſe, and which may be ſeen conſiderably enlarged in the annexed Plate.

The perfect kind of hoe-culture that can be given by means of the common plough, when applied in the manner that has been juſt recommended and explained, will, it is conceived, render the plants capable of advancing with a degree of vigour that can never be attained under any other circumſtances. The ground will be kept conſtantly moiſt, ſo that in the drieſt ſeaſons ever experienced in this climate their leaves will exhibit the moſt healthy verdure, and extend to ſuch a length, in turnips and cabbages eſpecially, as quickly to cloſe upon each other, and in a ſhort time leave no appearance of the rows. But, in order to prepare for this, it is obſerved, that the operations ſhould be haſtened, ſo as to put the ſoil into the fineſt poſſible tilth before the hoeing be finally cloſed; after which time the roots muſt be left at full liberty to ſpread with freedom in the fine mold that had been prepared for them; and the plants will thus be made to attain the utmoſt degree of perfection of which they are ſuſceptible.

This method of performing the buſineſs of horſe-hoeing has been practiſed by the inventor for more than twenty years, without having recourſe to any other, and afforded the moſt full and complete ſatisfaction. It has likewiſe been employed by others, to whom it had been recommended by the author, with the moſt complete ſucceſs; and, in conſequence, been conſidered as a very great improvement in the mechanical department of agriculture. It has alſo been

fuggefted as well fuited to the culture of the fugar-cane in the Weft Indies; and that, befides improving the tilth of the ground in fituations where it could be employed, the quantity of produce would be incalculably increafed, and the land kept in order at much lefs expence than in the common mode of cultivation. The crops in this way would, it is fuppofed, not only be more luxuriant, but lefs expofed to danger from dry feafons; the land continue longer capable of fupporting the plants without being exhaufted, and the operations of planting be finifhed with much greater expedition in bad feafons; befides, the danger of vermin would be confiderably diminifhed *.

Rotation of Crops.—The proper cropping of arable land is a matter of the utmoft importance to the interefts of the farmer, as upon it in a great meafure muft depend the profits and advantages which he is to derive from his labour and induftry. It is conceived by an experienced agricultor in the weftern part of the kingdom, to be "the moft prominent feature in good farming;" and that by which the produce of the foil may be increafed in a three-fold proportion †. And by another, in a more fouthern diftrict, as one of the moft important fubjects that can occupy the attention or exercife the ingenuity and fkill of the agriculturift ‡.

That it demands much regard by the cultivator is fully evinced by the great advantages that have been gained by it within the laft twenty or thirty years, fince its principles have become more perfectly underftood, and more extenfively applied. It has, indeed, been well remarked, that wherever either very good or very bad hufbandry is found on arable land, it refults more from the right or wrong arrangement of crops than from any other circumftance. And that no diftrict is well cultivated under bad rotations, while it is exceedingly rare to fee any badly managed under good ones ||.

In the arrangement of this bufinefs, as it has been feen that different forts of plants or crops may not only require different kinds and proportions of nutritious materials to be drawn from the earth for their increafe and perfect growth, but alfo different fituations and conditions of foil; it muft be neceffary to adapt them, as much as poffible, to the peculiar qualities of the foil, as well as the ftate of the land, and the nature of the climate in which it is placed: and as, on the fame principles, fome forts of crops may exhauft or deteriorate the foils on which they grow in much lefs proportions than others, as is well known to be the cafe with many kinds of what are termed *green* crops, when compared with

* Recreations in Agriculture, &c. vol. II. p. 345.

† Billingfley's View of the Agriculture of Somerfetfhire.

‡ Middleton's Report of the State of Agriculture in Middlefex.

|| Young's Annals, vol. XXIII.

thoſe of the *white* or corn kind, it will be requiſite to alternate or interpoſe them in ſuch a manner, as that the ground may ſuſtain the leaſt poſſible injury in that way. In addition to theſe, it may likewiſe be of great utility to attend to other circumſtances, as thoſe of introducing ſuch ſorts of green crops as are moſt ſuited, by the ſhade of their leaves and the kind of culture which they require while growing, for keeping the ground clean from weeds, and in a mellow and ſuitable ſtate for the reception of the more valuable kinds of grain crops, as in this way the neceſſity of having recourſe to the uneconomical proceſs of fallowing may be conſiderably leſſened *.

And as moſt ſorts of ſoils, when continued for any great length of time, either under grain or graſs, are liable to ſuſtain injury, and become leſs capable of producing full crops ;—in the firſt caſe, probably from the carbonaceous principle being too greatly exhauſted ; and in the latter, from the occurrence of moſs, or other noxious vegetable productions, that eſtabliſh themſelves in conſequence of the weak and imperfect growth of the graſs plants ;—it may be proper to occaſionally alter and change the nature of their crops, by keeping them for a while, after being broken up from graſs, under the plough, and then reſtoring them again to the ſtate of graſs ; as, in this way, the deficient principles may probably be the moſt readily ſupplied where manure, in ſufficient quantities, cannot be procured, and the injurious vegetable products be the moſt effectually removed.

It is likewiſe to be conſtantly kept in view, in directing the modes of cropping lands, that ſuch an intermixture of green, root, pea, bean, and grain crops be grown, as will not only be beſt adapted to keep the ſoil in the moſt perfect order, but ſuit the demands of the agricultor, for the purpoſes of ſale, as well as the keeping of ſuch numbers of different ſorts of live ſtock as may be proportionate to the ſupplying of thoſe quantities of manure that may be requiſite for preſerving the farm in the moſt perfect condition.

* It is remarked by Mr. Middleton, in the work quoted above, that " the aggregate benefits that will be derived to the country from this meaſure, are not to be eſtimated : but among the firſt of theſe will ſtand the *abolition of fallows,* and the introduction of *green crops* to ſupply their place, over an extent of *about three millions of acres of arable land,* which have hitherto, under the fallow ſyſtem, produced nothing uſeful during the fallow year. So far as tares and turnips, or potatoes ; or peas and turnips, or potatoes ; or any *two good crops*, can be raiſed in one year, in place of a fallow, the produce will be *double* in quantity what it has been under the former ſyſtem †."

† " There are," it is added, " about nine millions of acres in England and Wales, in the courſe of two crops and a fallow ; *i. e.* ſix in crop and three in fallow. Hence it follows that, by procuring *one* crop in lieu of the fallow, fifty per cent. is added to the former produce. But ſo far as *two* crops can be obtained in place of a fallow, it adds 100 per cent. or double the former number of acres of produce."

In regulating the courfes of crops on all defcriptions of land, with the view of preventing their exhaufting the foil, it will be neceffary to guard againft the occurrence of grain, potatoe, or other crops of a fimilar kind in fucceffion, as the refult of experiments attentively made, as well as the experience of the moft correct agricultors, in different diftricts, have decidedly fhewn their effects to be very powerful when employed in fuch a manner, in deteriorating and leffening the productive powers of the ground. In the trials of Mr. Arthur Young, which feem to have been conducted with a confiderable degree of accuracy and attention, on a foil of the fandy loam kind, incumbent on a wet clay marle bottom rendered dry by means of hollow draining, and of the annual value of about fifteen fhillings the acre, broken up from the ftate of grafs under which it had been for a great length of time, and ploughed into ridges in contrary directions each fucceeding year, no manure being applied except on particular lands or ridges in the fourth; though two or three white crops in fucceffion were found to exhauft in a high degree, potatoes had a ftill greater effect in the fame way, much more than barley in moft cafes, and in fome courfes even more than wheat*.

The refults of thefe trials are equally curious and interefting, as they not only demonftrate the advantages that may arife from the alternation of different forts of crops in different ways, but the effects of various rotations, both good and bad, upon the foil, and the produce derived from it. They would, however, have been more fatisfactory if the nature of the land had admitted the turnip and cabbage crops to have been confumed upon the ground, as no certain conclufions can probably be drawn where this is not the cafe; for though a proportionate quantity of manure may be afterwards returned to the land, its application in that way does not feem to afford fuch beneficial effects as when gradually incorporated with the foil during the time the animals are feeding on it, upon fuch luxuriant vegetable fubftances. Befides, the effects of the urine and perfpiration, which are known to be of confiderable utility in ameliorating the earth, are wholly loft.

Tare, clover, and other graffes of the artificial kinds, fhould likewife have been introduced, as by fuch kinds of crops the rotations would not only have been more varied, but the effects of different combinations more fully fhewn †.

* Annals of Agriculture, vol. XXIII.

† It is ftated by the ingenious experimenter, that all the work of tillage was performed by the common implements of the farm, and that the crops, in the whole of the thirty-fix courfes, were reaped and threfhed directly diftinct from each other, to obviate the danger of mixing and errors; and that they are minuted acreably to fave the trouble of calculation. In the valuation, all the ftraw is rated at 10s. an acre, and the crops are likewife eftimated, that the fluctuations of price may not affect the ge-

But, in order to afford the moſt full and complete view of the effects of different rotations of crops, it would be neceſſary to compare them on ſoils of different qualities, and which vary much in reſpect to ſoil, climate, and ſituation.

ROTATION I.

Courſe.	Produce.	£.	s.	d.
1 Beans	3 qrs. 1 buſhel	4	5	0
2 Turnips	8 tons 6 cwt.	1	13	0
3 Wheat	2 qrs. 5 buſhels	5	15	0
4 Potatoes	234 buſhels	5	17	0
5 Beans	3 qrs.	4	2	0
6 Wheat	3 qrs. 3 buſhels	7	5	0
		28	17	0
	Per annum . £.	4	16	2

ROTATION II.

Courſe.	Produce.	£.	s.	d.
1 Beans	3 qrs. 1 peck	4	2	9
2 Cabbages	6½ tons	1	12	6
3 Wheat	2 qrs. 5 buſhels	5	15	0
4 Cabbages	7 tons	1	15	0
5 Beans	3 qrs. 7 buſhels	5	3	0
6 Wheat	3 qrs. 3 buſhels	7	5	0
		25	13	3
	Per annum . £.	4	5	6½

ROTATION III.

Courſe.	Produce.	£.	s.	d.
1 Beans	3 qrs. 1 buſh. 1 peck	4	5	9
2 Potatoes	150 buſhels	3	15	0
3 Wheat	2 qrs. 2½ buſhels	5	2	6
4 Cabbages	5½ tons	1	7	6
5 Beans	3 qrs. 5 buſhels	4	17	0
6 Wheat	3 qrs. 1 buſhel	6	15	0
		26	2	9
	Per annum . £.	4	7	1½

The able experimenter has thrown out many uſeful obſervations on the different courſes, which we ſhall preſent to the reader in as conciſe a manner as poſſible.

The effects of the above rotations lead to different concluſions; in the firſt, in which there are four green fallow crops to two of the white or grain kind, little advantage is ſhewn except in the leaving of the land in fine tilth, and perfectly clean. Nothing of ſuperiority is ſhewn, it is obſerved, by the quantities of produce for lands newly broken up. It is, however, well remarked, that the turnips, by being drawn and removed from the land, were not favourable, as wheat on turnip ground is not generally good, except well trodden by feeding. Potatoes appear to exhauſt; and the experimenter ſuggeſts, that, eſtimating thirty tons of yard

neral concluſions;—the turnips at 4s. a ton, carted off; cabbages at 5s.; wheat 5s. a buſhel; barley 2s. 6d.; oats 2s. 3d; beans 3s.; potatoes 6d.: any other value may however be put upon them according to circumſtances.

compoſt, the proportion employed, at any imaginable rote, the courſe cannot be adviſable; the loſs on the potatoe crop would not, he thinks, be leſs than five pounds, nor would the turnips pay ſo as to leave a profit equal to the expences of newly broken up land for the firſt ſix years *.

The ſecond is ſtated as a more profitable courſe from the great charge of the potatoes not being incurred: and it ſhews, that though cabbages cannot be grown to any great advantage on ſuch ſoils without manure, they may be of much utility by the pulveriſation and cleanneſs which they afford. The goodneſs of the grain crops evinces, it is ſuppoſed, that they exhauſt but little, and that it is of great importance to have few white crops in rotations. And the third explains the neceſſity of manuring for potatoes on all ſoils, except ſuch as are rich and dry; with only two white crops in ſix years, the land ſeems rather, it is obſerved, to improve notwithſtanding the potatoe crop. The goodneſs of the laſt crop of wheat, in compariſon with the firſt, proves the ſuperiority of cabbage and bean crops over thoſe of beans and potatoes, in cleaning and rendering the ground mellow and fit for the growth of wheat.

ROTATION IV.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. $1\frac{1}{4}$ buſhel	4	5	9
2 Beans	4 qrs. 2 buſhels	5	12	0
3 Wheat	2 qrs. $3\frac{1}{2}$ buſhels	5	7	6
4 Cabbages	$6\frac{1}{2}$ tons	1	12	6
5 Beans	4 qrs.	5	6	0
6 Wheat	3 qrs. 1 buſhel	6	15	0
		28	18	9
	Per annum . £.	4	16	$6\frac{1}{2}$

ROTATION V.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 2 buſhels	4	8	0
2 Barley	3 qrs. 1 peck	3	10	7
3 Wheat	2 qrs. 2 buſhels	5	0	0
4 Barley	2 qrs. 2 pecks	2	11	5
5 Beans	2 qrs.	2	18	0
6 Wheat	1 qr. 7 buſhels	4	5	0
		22	13	0
	Per annum . £.	3	15	6

ROTATION VI.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 1 buſh. $1\frac{1}{2}$ peck	4	5	5
2 Wheat	2 qrs. 7 buſhels	6	3	0
3 Wheat	1 qr. 6 buſhels	4	0	0
4 Wheat	2 qrs.	5	2	6
5 Beans	1 qr. 7 buſhels	2	15	0
6 Wheat	1 qr. 4 buſhels	3	10	0
		25	15	11
	[Per annum . £.	4	6	0

* Young's Annals, vol. XXIII.

The refults of thefe courfes are highly interefting and important; by the firft the utility of repeated bean crops in cleaning land, and when combined with cabbages in preferving the fertility of fuch as is newly broken up, is clearly fhewn. When compared with the firft rotation, which ends in the fame way, its advantages alfo appear great in different other refpects. By the two laft the difadvantages attending fucceffive crops of corn are particularly brought to view. It is well remarked by the intelligent experimenter, that they alfo fhew that any fort of corn crops will fucceed to a certain extent on lands recently broken up from the ftate of old grafs; and that for the firft two or three years they may afford a produce proportionate to the fort of crop that is fown. But that the three laft years, on being compared with the three firft, the whole ftill in corn, the product was in the proportion of 9*l.* 14*s.* 5*d.* to 14*l.* 18*s.* 7*d.* or a decreafe of more than 5*l.*; while, in the preceding courfes, with better rotations, the products have fomewhat increafed. The difference, he fays, is therefore enormous. The decline in the barley, and even the wheat crops, notwithftanding the intervention of beans in the latter cafe, is very great. Befides, they leave the land in a bad condition, being in the fourth and fixth years fuch a bed of weeds as could not be half deftroyed by the hoeing of the beans. In thefe inftances the land not being left worth eleven fhillings an acre, while in fome of the preceding it was left of the value of fixteen. Thefe, it is well obferved, are the prejudicial effects of adopting bad rotations of cropping, from the circumftance of old grafs lands being capable of affording a good produce for a time. The fame confequences may likewife take place even upon foils of a much better quality, by fuch methods of cropping. It is evident that they fhould, therefore, be avoided as much as poffible on all defcriptions of foil by the correct agricultor. The laft courfe not only difplays the badnefs of the practice of taking fucceffive grain crops, but that beans, by the aid of the hoeing culture, cannot afford a produce, even on newly broken up land, that will repay the trouble and expence of the cultivator.

ROTATION VII.

Courfe.	Produce.	Value. £.	s.	d.
1 Beans .	3 qrs.	4	2	0
2 Turnips	4 tons . . .	0	16	0
3 Beans .	5 qrs. 2 bufhels .	6	16	0
4 Potatoes	234 bufhels . . .	5	17	0
5 Beans .	3 qrs.	4	2	0
6 Wheat .	3 qrs. 4 bufhels .	7	10	0
		29	3	0
	Per annum . £.	4	17	6

ROTATION VIII.

Course.	Produce.	Value. £.	s.	d.
1 Beans .	3 qrs. 1 bushel . .	4	5	0
2 Cabbages	6 tons	1	10	0
3 Beans .	3 qrs.	6	10	0
4 Cabbages	6½ tons	1	12	6
5 Beans .	4 qrs. 2 bushels .	5	12	0
6 Wheat .	3 qrs. 6 bushels .	8	0	0
		27	9	6
	Per annum . £.	4	11	7

ROTATION IX.

Course.	Produce.	Value. £.	s.	d.
1 Beans .	3 qrs.	4	2	0
2 Potatoes	147 bushels . .	3	13	0
3 Beans .	4 qrs.	5	6	0
4 Cabbages	6½ tons . . .	1	12	6
5 Beans .	4 qrs. 2 bushels .	5	12	0
6 Wheat .	3 qrs. 5 bushels .	7	15	0
		28	0	6
	Per annum . £.	4	13	5

The produce of the first of these courses, though there is only one grain crop in the six years, is, it is observed, so considerable as to shew the disadvantage of deteriorating rotations, especially as the circumstances under which they are put in, are supposed by some to be unfavourable, on account of the land, after turnips and potatoes, from the tillage which is required for such crops, being left in too light a state for the growth of beans. It has the advantage also of leaving the land perfectly clean, and in a fertile condition. And likewise proves, in the writer's opinion, that great attention may be had to the keeping of land clean, and in heart, by gentle modes of cropping, without the danger of immediate injury being sustained by it. It is further supposed that if beans or wheat had been the crop of the fourth year upon the manure in place of the potatoes, the profit on the whole would have been more, without the ground being left in a less rich condition.

The two last courses demonstrate, that from there being but one grain crop in six years, though cabbages, by being removed from the land, exhaust; three crops of beans are sufficient to preserve the land for a good wheat crop, besides leaving it in a good state. They are, therefore, profitable courses, and such as are suited to the obtaining of perfect cleanness of culture. In the latter course, the profit is, however, less, from the circumstance of potatoes being introduced.

ROTATION X.

Course.	Produce.	Value. £.	s.	d.
1 Beans .	3 qrs.	4	2	0
2 Beans .	4 qrs.	5	6	0
3 Beans .	4 qrs. 6 bushels .	6	4	0
4 Cabbages	8½ tons	2	2	6
5 Beans .	4 qrs.	5	6	0
6 Wheat .	4 qrs. 1 bushel . .	8	15	0
		31	15	6
	Per annum £.	5	5	11

ROTATION XI.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 7 pecks	4	2	9
2 Barley	4 qrs. 7 bushels	5	7	6
3 Beans	4 qrs.	5	6	0
4 Barley	5 qrs. 4 bushels	7	0	0
5 Beans	4 qrs. 1 bushel	5	9	0
6 Wheat	3 qrs. 1 bushel	6	15	0
		34	0	3
	Per annum . £.	5	13	4

ROTATION XII.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs.	4	2	0
2 Wheat	2 qrs. $6\frac{1}{2}$ bushels	6	2	6
3 Beans	3 qrs. $2\frac{1}{2}$ bushels	4	9	6
4 Wheat	3 qrs. $3\frac{3}{4}$ bushels	7	8	9
5 Beans	3 qrs.	4	2	0
6 Wheat	3 qrs.	6	10	0
		32	14	9
	Per annum . £.	5	9	1

It is evident, from the first of these courses, that successive crops of beans have a considerable ameliorating power, as both the cabbages and beans after them were very good. Their effects in preserving the fertility arising from the old turf is likewise obvious, as well as that of keeping the land perfectly free from weeds, at the same time that a good profit is afforded. It also affords a strong proof of the advantage of a careful method of cropping newly broken up lands.

Such courses should, consequently, be more frequently employed on all those stiff and retentive descriptions of land on which beans can be grown, both with the view of immediate profit, and the benefits that ensue from the land being kept clean.

The second course affords, in the writer's opinion, an example of a good and correct mode of practice, without much exhaustion, though, if compared with the preceding course, there appears to be a slight degree of deterioration from the wheat, in that being a quarter more. It may, however, be adopted as a very profitable rotation. The last of these courses is well known to be a very profitable one on the richer sorts of heavy soils; and it is here shewn to answer well on such as are of an inferior quality, even without the application of manure. The power of bean crops, in preserving the fertility of lands newly broken up from sward, is likewise evinced by the sixth crop, though inferior to others. This rotation should not, however, in general be attempted, except on the richest kinds of heavy soils.

ROTATION XIII.

Course.	Produce.	£.	s.	d.
1 Turnips .	3 tons	0	12	0
2 Ditto . .	$5\frac{1}{2}$ tons	1	2	0
3 Oats . .	9 qrs.	8	12	0
4 Potatoes .	252 bushels . .	6	6	0
5 Beans . .	3 qrs. 1 bushel .	4	5	0
6 Wheat .	3 qrs. 3 bushels .	7	5	0
		28	2	0
	Per annum . £.	4	13	8

ROTATION XIV.

Course.	Produce.	£.	s.	d.
1 Turnips .	3 tons . . .	0	12	0
2 Cabbages .	6 tons . . .	1	10	0
3 Oats . .	10 qrs. $5\frac{1}{2}$ bushels .	10	2	4
4 Cabbages .	8 tons . . .	2	0	0
5 Beans . .	3 qrs. 5 bushels .	5	17	0
6 Wheat .	3 qrs.	6	10	0
		26	11	4
	Per annum . £.	4	8	6

ROTATION XV.

Course.	Produce.	£.	s.	d.
1 Turnips .	$3\frac{1}{2}$ tons . . .	0	14	0
2 Potatoes .	154 bushels . .	3	17	0
3 Oats . .	8 qrs. $5\frac{1}{4}$ bushels .	8	1	11
4 Cabbages .	8 tons . . .	2	0	0
5 Beans . .	3 qrs. 5 bushels .	4	17	0
6 Wheat .	3 qrs. 1 bushel .	6	15	0
		26	4	11
	Per annum . £.	4	7	6

The first of the above courses exhibits the utility of repeated turnip crops in the preparation of this kind of soil for grain crops, the produce of the oats, from the pulverisation they effected, being very great. It is observed that oats are mostly sown on newly broken up lands, but never with much success on such as are wet. The exhaustion of the soil in this course seems not to have been great, though the oats were followed by potatoes, which are known to exhaust, as the succeeding bean and wheat crops were both good, but more especially the latter.

It is obvious, however, that as turnips and cabbages cannot be produced to advantage on such cold wet soils without much manure, that such rotations must be the most beneficial and proper on the drier sorts of land, where such crops can be grown and fed on the ground.

It is observed by the experimenter, that the gross product in the second course is not to be compared with the first, as the potatoes, affording six guineas,

left no profit. The largeneſs of the produce of oats ſeems to ſhew the beneficial effects of cabbage crops in preparing the ſoil. The inferiority of the wheat crop, when compared with that in the firſt of theſe rotations, is ſuppoſed to depend on the want of manure. Notwithſtanding there are two crops of cabbages and one of turnips in this courſe, it appears, the author ſays, to be profitable. It would ſeem, however, to be the moſt ſuited to the dry kinds of ſoils.

In comparing the third rotation with the two that precede it, the deteriorating properties of potatoes are evidently much greater than thoſe of either turnips or cabbages, from the inferiority of the oat crop that followed them. It is indeed ſuggeſted by the inſtitutor of the experiment, that "wherever potatoes inter with a ſmall produce, the expences more than abſorb the value."

Rotation XVI.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Beans	4 qrs.	5	6	0
3 Oats	8 qrs. 7 buſhels	8	9	9
4 Cabbages	6 tons	1	10	0
5 Beans	3 qrs. 6 buſhels	5	0	0
6 Wheat	3 qrs. 2 buſhels	7	0	0
		27	17	9
	Per annum	£. 4	12	11

Rotation XVII.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	5½ tons	0	14	0
2 Barley	5 qrs. 1 peck	5	0	7
3 Oats	5 qrs. 5 buſhels	5	11	3
4 Barley	4 qrs.	4	10	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs.	4	10	0
		24	7	10
	Per annum	£. 4	1	3

Rotation XVIII.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Wheat	2 qrs. 7 buſhels	6	5	0
3 Oats	4 qrs. 6½ buſhels	4	16	1
4 Wheat	2 qrs. 3 buſh. ½ peck	5	5	
5 Beans	2 qrs.	2	18	0
6 Wheat	1 qr. 7 buſhels	4	5	0
		24	1	5
	Per annum	£. 4	0	2

The reſult of the firſt of the above courſes diſplays the advantage of beans over potatoes in reſpect to profit. In the ſecond rotation the land being left

foul and in bad condition, ſhews, by the lightneſs of the wheat crop, when compared with thoſe in other courſes, that great exhauſtion had been produced by it. The laſt rotation exhibits a ſtill worſe practice; and that the land is left in a more deteriorated and foul ſituation by three wheat crops. Such courſes can, therefore, never be had recourſe to with either the view of profit or that of keeping the land in order.

Rotation XIX.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	106 buſhels	2	13	0
2 Turnips	$4\frac{1}{2}$ tons	0	18	0
3 Potatoes	136 buſhels	3	8	0
4 Potatoes	198 buſhels	4	19	0
5 Beans	2 qrs.	2	18	0
6 Wheat	1 qr. 6 buſhels	4	0	0
		18	16	0
	Per annum	£. 3	2	8

Rotation XX.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	105 buſhels	2	12	6
Cabbages	5 tons	1	5	0
3 Potatoes	110 buſhels	2	15	0
4 Cabbages	4 tons	1	0	0
5 Beans	2 qrs. 2 buſhels	3	4	0
6 Wheat	2 qrs.	4	10	0
		15	6	6
	Per annum	£. 2	11	0

Rotation XXI.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	104 buſhels	2	12	0
2 Ditto	126 buſhels	3	3	0
3 Ditto	97 buſhels	2	8	6
4 Cabbages	3 tons	0	15	0
5 Beans	1 qr. 7 buſhels	2	15	0
6 Wheat	1 qr. 4 buſhels	3	10	0
		15	3	6
	Per annum	£. 2	10	7

By theſe courſes, the deteriorating effects of potatoe crops are fully demonſtrated. With manure, in the proportion already explained in the fourth crop, the beans which ſucceeded were a very poor produce; and the wheat, though the only white crop in ſix years, is ſtated to be a "miſerable produce in a very good year." It is obſerved that in the fourth courſe, where there were two

crops of wheat, with three of beans, the concluding wheat crop afforded three quarters one bufhel without any manure ; a difference that is highly ftriking. And that in the eighth, three crops of beans, and two of cabbages, were followed with very good wheat, though cabbages removed from the ground exhauft ; but in thefe courfes there are fcarcely any, except fucceffive wheat crops, that exhauft the land fo greatly as potatoe crops.

The fecond courfe difplays little elfe, in the writer's opinion, than a continued lofs ; and the third affords a proof of the loweft decreafe of produce that can be fuppofed on newly broken up land ; befides, the foil left fo foul and deteriorated, that the whole of its fertility, from improvement, and the decay of the old turf, appears removed. It makes ftrongly againft potatoes, which can probably only be introduced with advantage as a cleaning crop, and where manure is plentiful.

Rotation XXII.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bufhels	2	10	0
2 Beans	3 qrs.	4	2	0
3 Potatoes	142 bufhels	3	11	0
4 Barley	5 tons	1	5	0
5 Beans	2 qrs. 3 bufhels	3	10	0
6 Wheat	2 qrs. 1 bufhel	4	15	0
		19	13	0
	Per annum . £.	3	5	6

Rotation XXIII.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	101 bufhels	2	10	6
2 Barley	4 qrs. 7 bufhels	5	7	6
3 Potatoes	127 bufhels	3	3	6
4 Barley	3 qrs. 2 bufhels	3	15	0
5 Beans	2 qrs. 7 bufhels	3	19	0
6 Whea	2 qrs. 5 bufhels	5	15	0
		24	10	6
	Per annum . £.	4	1	9

Rotation XXIV.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bufhels	2	10	0
2 Wheat	2 qrs. 1 bufhel	4	15	0
3 Potatoes	104 bufhels	2	12	0
4 Wheat	2 qrs.	4	10	0
5 Beans	2 qrs. 2 bufhels	3	4	0
6 Wheat	1 qr. 6 bufhels	4	0	0
		21	11	5
	Per annum . £.	3	11	10

By the firft of thefe courfes the exhaufting effects of potatoes is rendered ftill more evident, but the effects of the beans are fomewhat different.

From the fecond it is clear that barley fucceeds better after potatoes than wheat, while the inferiority of the fecond crop proves that the preparation they afford is not perfectly fuitable, and that the wheat that fucceeds is affected by their deteriorating property. The third courfe, befides confirming different refults that have been ftated, affords, by a comparifon with the twelfth, proofs of the utility of alternating beans and wheat.

Rotation XXV.

Courfe.	Produce.	£.	s.	d.
1 Potatoes	98 bufhels	2	9	0
2 Turnips	4 tons	0	16	0
3 Cabbages	$5\frac{1}{2}$ tons	1	7	6
4 Potatoes	270 bufhels	6	15	0
5 Beans	2 qrs. 2 bufhels	3	4	0
6 Wheat	2 qrs. 2 bufhels	5	0	0
		19	11	6
	Per annum . £.	3	5	3

Rotation XXVI.

Courfe.	Produce.	£.	s.	d.
1 Potatoes	101 bufhels	2	10	6
2 Cabbages	6 tons	1	10	0
3 Cabbages	$5\frac{1}{2}$ tons	1	7	6
4 Cabbages	3 tons	0	15	0
5 Beans	2 qrs. 6 bufhels	3	16	0
6 Wheat	2 qrs. 2 bufhels	5	0	0
		14	19	0
	Per annum . £.	2	9	10

Rotation XXVII.

Courfe.	Produce.	£.	s.	d.
1 Potatoes	100 bufhels	2	10	0
2 Potatoes	115 bufhels	2	17	6
3 Cabbages	$3\frac{1}{2}$ tons	0	17	6
4 Cabbages	$3\frac{1}{2}$ tons	0	17	6
5 Beans	2 qrs. 2 bufhels	3	4	0
6 Wheat	2 qrs.	4	10	0
		14	16	6
	Per annum . £.	2	9	5

In the firft of the above courfes, though the potatoes of the fourth crop were manured for as has been explained, the poornefs of the wheat crop, which was the only one of the grain kind in fix years, proves, it is fuppofed, the exhaufting effects of cabbage and turnip crops, when removed from the ground, in combination with potatoes, to be confiderable; and from the fecond it is evident that cabbages, when not confumed upon the foil, are fo prejudicial as not

to permit the ameliorating powers of beans to fecure a favourable crop of wheat. Neither this nor the preceding courfe is, therefore, profitable. The laft is obferved to be a rotation of nothing but lofs, and which further fhews the exhaufting effects of potatoes and cabbages, when removed from the ground, to be very confiderable.

ROTATION XXVIII.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes .	96 bufhels . .	2	8	0
2 Beans . .	3 qrs. ½ peck .	4	2	4
3 Cabbages .	6½ tons . . .	1	12	6
4 Cabbages .	4 tons . . .	1	0	0
5 Beans . .	2 qrs. 2 bufhels .	3	4	0
6 Wheat .	2 qrs. 3 bufhels .	5	5	0
		17	11	10
	Per annum . £.	2	18	7

ROTATION XXIX.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes .	100 bufhels . .	2	10	0
2 Barley .	4 qrs. 7½ bufhels .	5	8	9
3 Cabbages .	4 tons . . .	1	0	0
4 Barley .	4 qrs. 1 bufhel .	4	12	6
5 Beans . .	3 qrs. . . .	4	2	0
6 Wheat .	2 qrs. 6 bufhels .	6	0	0
		23	13	3
	Per annum . £.	3	18	10

ROTATION XXX.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes .	99 bufhels . .	2	9	6
2 Wheat .	2 qrs. 7 bufhels .	6	5	0
3 Cabbages .	4½ tons . . .	1	2	6
4 Wheat .	3 qrs. 6 bufh. 1½ pks.	8	1	6
5 Beans . .	2 qrs. 6 bufhels .	3	16	0
6 Wheat .	2 qrs. . . .	4	10	0
		26	4	6
	Per annum . £.	4	7	5

It is obferved that the rotations in which potatoes and cabbages not confumed on the land enter in any confiderable degree, all fhew the fame thing; which is, that, under particular circumftances, they are both prejudicial in exhaufting the foil.

The two latter of the above courfes, when compared with thofe of eleven and twelve, difplay the advantages of beans over potatoes and cabbages in a very ftriking manner.

ROTATION XXXI.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bufhels	2	10	0
2 Turnips	4 tons	0	16	0
3 Turnips	5 tons	1	0	0
4 Potatoes	288 bufhels	7	4	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 7 bufhels	6	5	0
		21	17	0
	Per annum . £.	3	12	10

ROTATION XXXII.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bufhels	2	10	6
2 Cabbages	5 tons	1	5	9
3 Turnips	4 tons	0	16	0
4 Cabbages	4 tons	1	0	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 6 bufhels	6	0	0
		15	13	6
	Per annum .. £.	2	12	3

ROTATION XXXIII.

Courfe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bufhels	2	10	0
2 Potatoes	112 bufhels	2	16	0
3 Turnips	4 tons	0	16	0
4 Cabbages	$4\frac{1}{2}$ tons	1	2	6
5 Beans	2 qrs. 5 bufhels	3	13	0
6 Wheat	1 qr. 3 bufhels	5	5	0
		16	2	6
	Per annum . £.	2	13	9

The profit of the firft of thefe courfes is too trifling to recommend it; and the products of the fifth and fixth years' crops are fuggefted to be lefs than they ought to be, from the circumftance of manure being applied in the fourth, and there being only one grain crop in the courfe. Therefore potatoes, even when manured for, leave the foil in no very advantageous fituation for the growth of wheat, though affifted by the cleaning and improving qualities of beans.

The fecond and third courfes are equally decifive in fhewing the exhaufting effects both of potatoe and cabbage crops, when not confumed on the land, and that they are courfes that fhould feldom be employed where they cannot be manured for and fed off upon the ground.

ROTATION XXXIV.

Course.	Produce.	£.	s.	d.
1 Potatoes .	98 bushels . .	2	9	0
2 Beans . .	3 qrs. 1 peck . .	4	2	9
3 Turnips .	4 tons	0	16	0
4 Cabbages .	$5\frac{1}{2}$ tons . . .	1	7	6
5 Beans . .	3 qrs. . . .	4	2	0
6 Wheat .	2 qrs. 6 bushels .	6	0	0
		18	17	3
	Per annum . £.	3	2	10

ROTATION XXXV.

Course.	Produce.	£.	s.	d.
1 Potatoes .	100 bushels . .	2	10	0
2 Barley .	4 qrs. 6 bush. 3 pks.	5	6	10
3 Turnips .	4 tons . . .	0	16	0
4 Barley .	4 qrs. . . .	4	10	0
5 Beans .	3 qrs. . .	4	2	0
6 Wheat .	3 qrs. . . .	6	10	0
		23	14	10
	Per annum . £.	3	19	1

ROTATION XXXVI.

Course.	Produce.	£.	s.	d.
1 Potatoes .	100 bushels . .	2	10	0
2 Wheat .	2 qrs. 6 bushels .	6	0	0
3 Turnips .	4 tons . . .	0	16	0
4 Wheat .	2 qrs. 7 bush. $2\frac{1}{2}$ pks.	6	8	0
5 Beans . .	2 qrs. 6 bushels .	3	16	0
6 Wheat .	2 qrs. 6 bushels .	6	0	0
		25	10	0
	Per annum . £.	4	5	0

The first of the above rotations exhibits the effects of potatoes and cabbages still further. The second course also shews, that while the turf of newly broke up soils is in a state of decay, spring corn succeeds well after potatoe crops. It likewise proves, that three grain crops may be grown in six years without the soil being greatly exhausted, when proper attention is paid to the nature of the intervening crops.

The injurious consequences of cropping land with grain, and other sorts of crops, that exhaust in a high degree, may probably be prevented in the best manner on the more stiff and retentive sorts of land, whether of the clayey or loamy kinds, by the interposing of bean and clover, or tare crops, between them, as the experiments detailed above have shewn the former to possess the power of ameliorating the condition of such soils; and the latter seems not less calculated for the same purpose, as it is known to grow well on these sorts of land: and on those of a more light and dry quality, whether sandy

or of a gravelly nature, the intermixing of turnip, pea, and other crops of the fame fort, with thofe of corn, may be equally fuccefsful. In many cafes, efpecially on the more heavy kinds of foil, it may be neceffary and highly beneficial to take two green crops for one of grain. This is a practice, that the refults of the trials juft detailed place in an advantageous point of view, and which has extended itfelf over a confiderable tract of land with great fuccefs in the county of Middlefex; and by which, from the cleannefs of the cultivation, and the great vigour of the land, in confequence of the few corn crops, the grain is found of a fuperior quality. It is indeed remarked by a writer of confiderable experience, that land under common circumftances will not even bear, without injury, a corn crop every two years. This is fully fhewn, he conceives, by the turnip crops in Norfolk being uniformly found to be not only lefs certain, but much lighter than formerly, as well as from the fame remark being applicable to the clover, and probably to the corn crops. Such diminutions in the quantity of produce, he fuppofes, demonftrate that the valuable and favourite rotation of that diftrict, as turnips, barley, clover, wheat, is fomewhat more than the ground can fuftain, as it appears to be gradually finking under too much exhauftion. With the aid of extenfive fheep-walks, he thinks the foil not even able to fupport the depreffion of the prefent courfe of crops, efpecially when a five-years' courfe, by introducing barley after wheat, is injudicioufly had recourfe to *.

On inclofed lands, of different kinds, the fame author recommends the following courfes as the moft proper: For the beft forts of land, alternate green and white crops; for fuch as are of a full medium quality, three green crops for two of the grain or white kind; for ordinary land, two green for one of the corn fort; and for the worft, or that which is the moft exhaufted, as downs and fheep-walks, three green crops to one of the white or grain kind.

Cropping in thefe methods and proportions would, it is fuppofed, keep the lands perfectly free from weeds, and in a ftate of high culture, and, "*under fuch management, might be continued in perpetual aration, with a conftant fucceffion of large products* †." Befides, the farmer, it is imagined, by adopting fuch a fyftem, would not be idly flattered "by a *promifing feed-time*, and miferably difappointed by a *fcanty harveft*, as is frequently the cafe; but, on the contrary, be fure (at leaft as far as depends on human means) of reaping a plentiful return for all his labour and expence."

* Middleton's Report of the Agriculture of Middlefex, p. 158. † Ibid.

Various arrangements of crops, comprehending different numbers of the green kind to thofe of grain, may be formed. The following are judicioufly recommended by Mr. Middleton, and are in the proportions of from two to five of the former, to one of the latter:

1ft. Two green crops to one of corn.

Corn;	(or) Peas;
Clover;	Beans;
Peas:	Corn.

2d. Three green crops to one of corn.

Corn;	(or) Corn;
Clover;	Clover;
Tares;	Peas;
Turnips:	Beans.

Which is four crops in three years.

3d. Four green crops to one of corn.

Tares;
Potatoes, or cole, for fheep feed;
Turnips;
Corn;
Clover.

Making five crops in four years.

4th. Five green crops to one of corn.

Peas;
Beans;
Corn;
Clover;
Tares;
Turnips.

Making fix crops in five years.

By inculcating and adopting fuch methods of cropping as the above, the danger of exhaufting the fertility of the foil will not only be completely prevented, but the injurious confequences of weeds be guarded againft, which cannot be the cafe where repeated grain crops are grown in fucceffion, as the experiments detailed above fufficiently prove, and which are ftill further confirmed by the reports of different counties, that have been lately publifhed under the directions of the Board of Agriculture.

The following has been fuggefted as a courfe well adapted to *newly* broken up lands, of the heavier and more wet kinds, from the profit of beans being confiderable in all cafes where the foil has not been exhaufted, and from the circumftance of oats being a much more productive crop than either barley or wheat, while the graffy material of the old fward is in a ftate of decay, as is fully demonftrated in the preceding details. The clover reftoring the diminifhed fertility caufed by the alternate bean and oat crop, which the beans in the eighth year would have no tendency to leffen, while the wheat, after two fuch ameliorating crops, could fcarcely avoid being an abundant crop: 1, beans; 2, oats; 3, beans; 4, oats; 5, beans; 6, oats; 7, clover; 8, beans; 9, wheat*.

* Young's Annals of Agriculture, vol. XXIII.

It is evident, however, that fuch repeated cropping with grain crops, although ameliorating ones may be interpofed, muft foon confiderably reduce the fertility of the land, and of courfe can only be had recourfe to while there is a large portion of vegetable matter undergoing decompofition in the foil.

And it is recommended as an improvement in the cropping of uninclofed lands, where, from the circumftance of turnip and clover crops not being capable of being much grown, no perfect fyftem of hufbandry can be purfued, to adopt the following courfe: firft year, barley; fecond year, clover, on as much as manure can be applied over to preferve the plants from fuftaining injury by the clofenefs of the bite of fheep; the remainder in peas in the drill method, which fhould be twice hoed, being earthed up at the latter operation; third year, wheat; fourth, potatoes, or fpring tares. When potatoes, they fhould be planted at fo early a period, as that they may admit of being taken up about the time cattle are to be turned in *. Where the foil is good, and fufficiently light, the early fort might probably be the moft proper in fuch cafes, efpecially in fituations near large towns, where there is great demand for them.

It has been found, by the experience of different cultivators, that fuch lands as have had their fertility greatly reduced by injudicious modes of cropping with grain in too frequent fucceffion, and which are thereby become foul, and in a bad condition, may often be reftored by cropping for three or four years in fuch courfes as that what are termed green crops may enter in very large proportion with more profit, and as little difficulty, as by being laid to the ftate of pafture. In this view the crops may be clover for two years; then cole, tares, or turnips, the land being previoufly manured; afterwards beans or peas, the crops being kept perfectly clean by repeated hoeing; and laftly barley, or in fome cafes, perhaps, wheat, with fuch grafs feeds as may be adapted to the nature of the foil. That this may be accomplifhed with great advantage in this way, there can fcarcely be a doubt; fince it has been proved by the experience of the moft correct agricultors, that any determinate quantity of land when cropped with clover, tares, turnips, or other fimilar crops, will produce twice as much food as when in the ftate of grafs †.

In the common methods of cropping, on ftrong, wet, clayey, or ftiff loamy foils, where it appears probable, as has been already feen, that the practice of a naked fallow may fometimes be required, it is the moft improved

* Middleton's Report of Middlefex.

† Cartwright, in Communications to the Board of Agriculture, vol. III

cuftom to make it the preparation for the firft grain crop, depending upon fome fort of green one for thofe that follow, without repeating it; as in this way: 1, fallow; 2, barley; 3, clover; 4, wheat. Or where manure is in abundance, a preferable courfe in fuch cafes may be: 1, fallow; 2, wheat; 3, beans; 4, barley; 5, clover; 6, wheat. But even on this defcription of foils it may be more advantageous to crop in this manner: 1, cabbages, beans, or peas; 2, barley or oats; 3, clover; 4, wheat: or 1, cabbages; 2, oats; 3, beans; 4, wheat: or to begin with 1, beans; 2, wheat; 3, cabbages; 4, barley; 5, clover; 6, wheat. And even in particular cafes, where there is good culture; 1, turnips; 2, oats; 3, vetches; 4, wheat.

In breaking up thefe foils from grafs by paring and burning, the courfe may be: 1, cole; 2, beans; 3, wheat; 4, beans; 5, wheat. Tares, though properly objected to by fome cultivators, as coming too late in the fpring on fuch foils, may fometimes be beneficially introduced for the purpofe of being eaten off by fheep, or mown green for horfes, milch cows, young ftock, and hogs *. By thefe modes of cropping, with proper attention to the eating the green crops off, where it can be done without injury, or the removing of them to be confumed in the farm-yards, or other places, in order to the manure being afterwards applied, the land may not only be improved by being rendered more friable, rich, and mellow, but be kept clean and free from weeds.

But on the richer defcriptions of loamy foils, as well as thofe of the fandy kind, it feems to be the practice of the moft improved arable diftricts to make turnips the preparation for the barley crop, and clover that for wheat, in this way: 1, turnips; 2, barley; 3, clover; 4, wheat. In this courfe oats may fometimes be fubftituted for the barley; and, inftead of the clover, tares, chicory, or fome other fort of artificial grafs feeds. When foils of this kind are broken up from the ftate of grafs, and the procefs of paring and burning adopted, the courfe fhould be: 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley; 7, clover; 8, wheat; 9, turnips; 10, barley. If the ground is to be kept in tillage only a fhort time, the moft proper courfe may be: 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley; with grafs feeds.

But where the practice of paring and burning is not adopted, which is by

* Cartwright, in Communications to the Board of Agriculture, vol. III.

no means fo common, it may be the beft method to begin by beans or peas dibbled, and then proceed in the fame manner as above. In thefe cafes the turnip and clover crops are always to be eaten off by fheep, or fome other kind of ftock.

In the more dry and light kinds of foils of this nature, pea crops may be introduced, efpecially thofe of the white fort dibbled as a firft crop, then proceeding with the other crops in the above manner. Where potatoes are begun with, more of the replenifhing crops will be required, on account of their greater deteriorating qualities.

On the merely fandy foils, in fome diftricts, turnips are made the preparation for grafs, as well as grain: and it is found that there are none of thefe foils fo light, as that they will not afford fuch a crop. The courfe is commonly, 1, turnips; 2, barley; 3, grafs feeds. The graffes in thefe cafes are to be cultivated with a view to the feeding of fheep, confequently fhould be fuch as will ftand for fome length of time, as it is by no means a good practice to break up again too foon; the flocks fed upon the turnips during the winter feafon not being provided with a due quantity of food on fuch *new* layers for their fummer fupport.

It is remarked that in Suffolk, on the better lands of this fort, the layers are often planted with peas, by dibbling, to much advantage, after being broken up, without being fed with fheep in the fummer. The fucceeding crop of wheat being in fuch methods much larger, the following courfe is faid to be an excellent one for fuch foils: 1, turnips; 2, barley; 3, trefoil and ray grafs; 4, peas dibbled; 5, barley *.

Where foils of this fort are poor, or partake of the nature of heaths or fheep walks, it may be the beft practice, in bringing them into arable cultivation, to, 1, pare and burn for turnips; 2, turnips; 3, barley, with grafs feeds. If they are intended to be kept under the plough longer than this courfe, the turnip and barley, and grafs crops, may be alternately repeated until the fifth or feventh year, or even longer, if it be thought neceffary.

And as we have feen that potatoes exhauft in a confiderable degree, where they are adopted as the firft crop; in breaking up fuch foils, they muft be fucceeded by ameliorating crops, fuch as turnips and grafs, as in the preceding courfes †. Where thefe foils are poor, and of the light blowing kind, their

* Young's Report of the County of Suffolk.

† Communications to the Board of Agriculture, vol. III. p. 136.

tenacity muft be increafed by the application of clay in fuitable proportions, and the reeding off the crops by fheep. But where thefe means cannot be adopted, the courfe recommended above will be the moft proper.

The gravelly and flinty foils, when of the lighter kinds, fhould be cropped in fuch a manner as may be the moft effectual in preventing their moifture from being diffipated, and their fertility from being impaired. In thefe views two or more green crops may often be neceffary for one of grain in the way that has been defcribed above; or 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley, with grafs feeds. Peafe, tares, and cole, may alfo be introduced with great propriety in courfes for thefe foils. Where flints abound, as hoeing cannot be practifed with facility, it has been recommended by an experienced cultivator to fow the turnips thinly, and mix a portion of cole-feed with them, by which means an abundance of fheep food may be produced *. The grain crops, efpecially thofe of the fpring kind, fhould always on fuch forts of foil, where fufficiently dry, be fown early, that they may cover the ground well before the hot feafon commences.

On the heavier defcriptions of thefe foils, beans or peas may, however, frequently be made the preparatory crops for barley, or even wheat, in this way: 1, beans or peas; 2, barley; 3, clover; 4, wheat; and which may be ftill further varied by tares and turnips, according to the particular ftate of the land.

On the thinner kinds of chalky foils, and fuch old down lands as are become fo unproductive of herbage as not to be capable of being continued in the ftate of fheep pafture, it may be the moft advantageous method of cropping when brought into tillage to make turnips or fome other luxuriant green crop, which, while it keeps the land clean, and produces a large proportion of green food for the fupport of fheep or other animals, is beneficial by preferving the moifture, which in fuch forts of foil is liable to be diffipated too quickly, the preparation for grain. In thefe intentions the courfe may be, 1, turnips; 2, barley; 3, clover; 4, wheat; or in fome cafes, as where feed weeds are liable to prevail much, two crops of turnips may be taken before any grain crop with utility and advantage. If it be intended to keep fuch lands longer in the ftate of tillage, two crops of turnips may be again grown after the wheat, which will leave the foil in a high ftate of preparation for barley, then faintfoin may be introduced, as affording an excellent pafture for fheep for feveral years. In thefe cafes the turnip and clover crops muft conftantly be fed off by fheep, which fhould not be removed from the land during the whole of the time the crops are in con-

* Boys in Communications to the Board of Agriculture, vol. III.

fumption, fuch other kinds of dry food as may be neceffary being conveyed to them. By thefe means the foil will be left in the beft poffible ftate for the growing of barley, without the trouble and expence that muft otherwife be incurred for manure.

In fome inftances, as where the land is fufficiently mellow and friable, the mode of cropping may be, 1, peas; 2, oats; 3, turnips; 4, barley, with grafs feeds; or if it be the intention of the cultivator to continue the courfe, he may proceed with turnips or peas as before, clofing the rotation with faintfoin, as affording a pafture for fheep for feveral years. By attention in cropping and managing lands of this nature, in the manner that has been juft defcribed, great improvements may be made, not only in rendering them capable of affording valuable grain crops, but as producing a much larger proportion of green food for the ufe of fheep and other animals.

In the cropping of peaty, moory, and fenny foils, after draining them of their injurious moifture, fome difference muft be made according as they are deep, or only poffefs a flight covering of the peaty matter. Where they are of the deeper kinds, it may be the moft judicious practice to make turnips, potatoes, cabbages, cole, or fuch forts of crops as produce much fhade, and by preferving the moifture in the more fuperficial parts of the foil, promote its decompofition and decay, the preparation for grain. In this view the crops may be, 1, turnips, cabbages or cole; 2, oats; 3, turnips, cabbages or cole, as before; 4, oats; 5, clover; 6, wheat; 7, turnips, &c. as above; 8, oats, with grafs feeds.

From the great exhaufting property of potatoe crops, they have been objected to by fome agricultors; but on foils of this kind, experience feems to fhew them to be highly ufeful. When they are employed the courfe may be, 1, potatoes; 2, oats; 3, turnips, cole or cabbage; 4, the fame; 5, oats, with grafs feeds. In the northern parts of Scotland, on foils of this kind, the employing of potatoes as a firft crop has been found to be by much the moft certain and advantageous mode, the fucceeding crops of oats being not only more certain, but greatly more abundant *.

But on the thinner defcriptions of thefe foils, as thofe of a moory and fenny nature, and where the fubfoil is of the ftiff and retentive kind, it may be the moft proper practice to begin with cole, and make it the preparation for grain crops in this way; 1, cole; 2, oats; 3, cole; 4, oats; or, 1, cole; 2, oats; 3, beans with dung; 4, potatoes; 5, wheat; 6, cole; 7, oats. But in this laft method,

* Modern Agriculture, vol. IV. p. 65.

as it is probable that by potatoes and wheat coming together there may be danger of the land being too much exhaufted, it may be better to omit the potatoes and introduce beans in their ftead, which we have feen to be an improving crop, in this way: 1, cole; 2, oats, the land being dunged; 3, beans; 4, wheat; 5, cole; 6, oats. It would feem alfo that on fome of thefe foils clover might be introduced with advantage as a preparation for the wheat crops. It is a matter of great confequence on fuch foils as thefe to have recourfe to judicious modes of cropping, as the improvements made on lands of this kind by fuch means are, in general, much greater than in other cafes.

In almoft all the heavier forts of land, where they are broken up from the ftate of old fward, it will be found that beans are by much the beft crop to begin with, though oats are moftly fown, as the decay of the turfy or graffy matter is fo favourable to their growth, that they feldom fail in fuch cafes of affording an abundant crop. Befides, the bean crops in this way contribute to render the fucceeding tillage more effectual, by the roots penetrating fo deeply into the foil, and thus in many inftances become an excellent preparation for wheat. On the lighter forts of foil, peas might likewife in many cafes be the moft advantageous crop to begin with. And as in lands that have remained a great length of time in the ftate of fward, there may be danger of the firft crops, after their being broken up, being injured by the ravages of worms and grubs, which are often found to exift in great abundance in them, it may be advifable, where they are much fufpected, to adopt the practice of paring and burning, or of turning the graffy furface completely under, to fome depth, by means of the trench-plough. The former is, however, by much the beft practice, though the latter may be highly ufeful where the grafs is coarfe and cannot be eafily removed *. But where neither of thefe methods is thought advifable, as beans are not fo liable to be attacked, it may be proper to repeat them. It has alfo been fuggefted, that advantage may be gained in this view, by keeping fuch grafs lands as are to be brought into tillage, as bare and clofely fed by fheep and other animals as poffible during the latter fummer months, as by that means the fly may not be fo much invited to depofit its ova, as where the grafs is left of greater length †.

Where the nature of the farm admits of the ground being cultivated under the alternate fyftem of grafs and corn, or in what is moftly termed convertible

* Dr. Wilkinfon, in Communications to the Board of Agriculture, vol. III. p. 340.

† Reverend Mr. Young, ibid. 138.

huſbandry, which, when every circumſtance is fully conſidered, is certainly a very advantageous method, it will be neceſſary in directing the courſe of crops not only to have regard to the particular quality of the land, but to the growing of ſuch ſorts of roots, plants, or other productions, as may, while they contribute to clean, improve, and prepare the ſoil for the production of abundant graſs crops, be the beſt adapted to the feeding, rearing, and maintaining of thoſe kinds of live ſtock that are to be kept, and that may afford the moſt abundant and regular ſupplies at the different ſeaſons when they are moſt wanted.

In this way the loamy, as well as the gravelly, fenny, and the thinner kinds of peaty ſoils, may be managed to great profit; as by their having many of the green crops fed off upon the land, much amelioration and improvement muſt be produced while in the ſtate of tillage, that muſt be favourable for the production of graſs, and by being occaſionally laid to graſs for a few years, and then thickly ſtocked with ſheep or other animals, they muſt undergo an excellent preparation for being again brought into tillage.

This ſort of huſbandry appears to be practiſed with great advantage in Northumberland, it having been found that, on the ſandy and dry light loamy ſoils, excellent grain crops, eſpecially oats, may be grown by the lands' remaining three years under graſs, cloſely eaten with ſheep, which could never be done while they were managed according to their old method of practice *.

Under this alternate ſyſtem of huſbandry, on the wetter and more ſtiff kinds of loamy ſoil, and where there is conſiderable fertility, the courſe may be, after breaking up, 1, beans or oats; 2, turnips; 3, barley; 4, clover, and ſometimes winter tares, according to circumſtances; 5, wheat; 6, turnip; 7, barley; 8, graſs ſeeds, to remain in the ſtate of paſture for three, four, or more years, as may be found the moſt ſuitable; or break up for, 1, oats; 2, beans; 3, wheat; 4, fallow and graſs for four or five years. But on thoſe of the drier deſcription, it may be more beneficial to begin with, 1, peas or turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley, with graſs ſeeds, to continue in the ſtate of paſture for not leſs than three years; or, in ſome caſes, the cultivator may begin with oats, then turnips, and afterwards barley with ſeeds, to remain in the ſtate of graſs for three or more years. It may likewiſe be uſeful where much green food is required, or there is an apprehenſion of danger from the wire-worm or grubs, to begin with turnips or cabbages, as ſuch crops moſtly ſucceed well in ſuch caſes when the turf is well

* Bailey and Culley's corrected Agricultural Report.

reduced and broken down by repeated harrowing, though not brought to a fine ſtate of mold *.

In a well-cultivated diſtrict in the northern part of the kingdom, different modes of cropping are ſaid to have been attempted in this view; and that of 1, turnips; 2, barley; 3, clover; 4, wheat, has been tried till there has been an evident falling off in the crops, eſpecially in thoſe of the green kind; the only means of recovering the lands in ſuch caſes being that of letting them remain, after their being three years under the plough, an equal length of time in the ſtate of graſs; "by this mode," it is obſerved, "nature has time to prepare a ſufficient *lea clod*, which, being turned up for the turnip fallow, will inſure a vigorous crop of turnips, as it is well known they always flouriſh upon freſh land, or where they find the remains of a *lea clod* to vegetate in †." And it is added, that the portion of ground "that is kept in graſs for three years, breeds and fattens ſuch a number of ſheep, as leave a conſiderable profit, probably equal to, if not more than, the arable crops ‡."

Theſe, as well as many other facts of the ſame kind, ſhew, in the moſt clear manner, the great benefits that may be derived from the cultivating of lands under the convertible method of farming. But in order that the agricultor may draw from it the greateſt poſſible advantage, he ſhould be well acquainted with the nature and management of different ſorts of live ſtock, with the beſt means of combining them with arable cultivation, and the moſt ready and convenient methods of breeding, rearing, and fattening them, under ſuch a connected ſyſtem of huſbandry.

It has been ſuggeſted to the cultivators of the lighter and more friable kinds of ſoils, or ſuch as are proper for the growing of barley, that where the keeping of live ſtock is the principal object, the following crops, in nearly the order

* Reverend Mr. Young, in Communications to the Board of Agriculture, vol. III.

† Bailey and Culley's corrected Report of the County of Northumberland.

‡ It is ſtated by the ſame writers that the yearly profit of a ſheep is eſtimated at not leſs than from twenty to thirty ſhillings; ſix or eight of which are fattened on an acre of clover, and on an acre of turnips double the number. By this ſyſtem, it is ſuppoſed, the principal advantages of folding are obtained without any of its inconveniences: for if upon an average

The firſt year's clover and graſs carry	7	ſheep an acre for	20 weeks,
2 - - - - -	5	- -	20,
3 - - - - -	3	- -	20,
And the turnips - - -	12	- -	20;
That is - - - -	27	ſheep per acre for	20 weeks: which is after the

rate of 540 per acre for one week, once in ſix years, leaving twenty-five ſhillings a-head profit.

in which they ftand, may be capable of fupplying a continued fucceffion of green food, of the beft quality, in abundance all the year round: namely; water-meadows—rye-grafs—rye, cut green—winter tares—clover, the firft crop—fpring tares—clover, the fecond crop—after-grafs of meadows; clovers and feeds of all forts—turnips—cabbages—potatoes—cole—Swedifh turnips—turnip-rooted cabbage.

" Whoever," fays the intelligent writer, " will attend to the raifing of the foregoing crops, on a fcale proportioned to the fize of his farm and the number of his *live ftock*, need not be ftraitened from want of food for *them* at any time or feafon of the year. It is evident," he thinks, " on a bare infpection of the lift, that, confidering the properties of the different plants, and the feafons when each of them is the moft fit for ufe, they complete the circle of the year. It may," fays he, " perhaps be ftarted as an objection, that many farms are without water-meadow:—very true; but then cole, Swedifh turnip, and turnip-rooted cabbage, might be produced in fuch quantity as to be fufficient for confumption in March and April, during which months, and part of May, they are in the higheft ftate of perfection. Thefe might be affifted, or even fuperfeded, by turnips, potatoes, carrots, parfnips, and even cabbages, all of which being gathered while in the greateft perfection, might be laid up in ftore-pies, both with or without froft or fnow, for fpring ufe. Water-meadows," continues he, " afford a vaft deal of food from the middle of March; rye-grafs from the 1ft of April; rye from the beginning of May; winter-tares foon follow; then comes clover, the firft crop; fpring tares; clover, the fecond crop; and the after-grafs of natural meadows, clover, &c.; which will continue in perfection for heavy cattle till early fown turnips are ready. Later fown turnips and cabbages will be fufficient till the end of February, without ftoring; about which time the cole, Swedifh turnip, and turnip-rooted cabbage, will come in, and continue good through March and April, and even May, if needful *."

Where lands are to be reftored to the ftate of grafs after fome time, if the hoeing fyftem be practifed in fuch a manner as that the different crops may be kept in a perfectly clean condition; and where the green kinds, fuch as thofe of turnips, peafe, and beans, are put in on three-feet ridges, in double rows, and thofe of the cabbage fort on fimilar ridges, but in fingle rows; the following rotations have been fuggefted, by an experienced cultivator †, as the moft fuited for any length of time to different forts of foil.

* Middleton's Report of the Agriculture of Middlefex.

† Clofe, in Communications to the Board of Agriculture, vol. III.

Clay - -	Turnips or Cabbages	Oats	Beans and Clover	Wheat	Turnips or Cabbages	Oats	Beans and Vetches	Wheat
Clayey loams - -	Turnips or Cabbages	Oats	Clover	Wheat	Turnips or Cabbages	Barley	Beans	Wheat
Rich loams, or Sandy loams -	Turnips and Potatoes	Barley	Clover	Wheat	Beans	Barley	Peaſe	Wheat
	Beans	Barley	Peaſe	Wheat	For any length of time			
	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
Peat earth - - -	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
Chalky ſubſtratum	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
					but on this ſoil ten acres in every hundred ſhould be laid with ſaintfoin for 8 or 10 years.			
Gravels - -	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	
Light lands - -	Turnips	Barley	Clover & Rye-graſs	Clover & Rye-graſs	Clover and Rye-graſs	Peaſe	Wheat or Rye	Wheat

On the whole, though no invariable rules can perhaps be laid down for the cropping of land, as much muſt conſtantly depend on ſoil, ſituation, climate, and other leſs important circumſtances, the chief objects to be aimed at in this buſineſs would ſeem to be thoſe of well adapting the crops to the nature of the lands and kinds of huſbandry that are to be purſued, and that of alternating the green and root kinds with thoſe of corn, in ſuch a way as that the ſoil, while it remains the leaſt poſſible time in an unproductive ſtate, may be the leaſt robbed of its fertility. In this manner the culture of the field may approach that of the garden, and the deteriorating effects of ſucceſſive grain crops be guarded againſt, at the ſame time that more abundant ſupplies of both human and cattle food are produced.

From the whole of what has been advanced in reſpect to the nature of cropping lands, it muſt be ſufficiently obvious that the cuſtom of reſtricting tenants to particular modes or courſes of cropping their farms, is not only diſadvantageous in preventing the introduction of uſeful improvements, but in leſſening the quantity of produce that may be obtained, without injuring the ſoil in any improper degree. The only circumſtances that would ſeem neceſſary to be particularly attended to by land-owners, are thoſe of preventing the too frequent ſucceſſions of grain crops, eſpecially thoſe of the more deteriorating kinds, and which have a great tendency to render the land foul from being repeated at too ſhort intervals; while at the ſame time the manure that is raiſed from ſuch crops, as well as that formed from the conſumption of thoſe of the green kind, be carefully reſtored to the land. Where regulations of this nature are ſtrictly enforced, it appears almoſt impoſſible that land ſhould be much injured by any modes of cropping that may be adopted.

However deſirable it may be, it is unqueſtionably a matter of much difficulty to point out ſuch proportions of crops of different kinds as may be generally applicable to arable farms of different deſcriptions, as it is obvious that in every caſe a great deal muſt depend not only on ſoil, climate, and ſituation, in reſpect to markets, but on the kind of huſbandry that is practiſed, as well as various other circumſtances of a local nature. It would ſeem, however, that the leading principles in this buſineſs ſhould be, that the extent of land in the ſtate of natural and artificial graſs be fully adequate to the ſupport of ſuch a number of live ſtock of different kinds as may be ſufficient to ſupply ſuch a proportion of manure as is neceſſary for keeping the portion of ground under grain, root, green, or other crops, in the moſt perfect heart and order. Hence the ſpace of ground, to be conducted under grain, root, green, and other arable crops, muſt conſtantly be proportioned to the quantity of manure that can be raiſed by the keeping of different ſorts of domeſtic animals, while the number of the laſt muſt be regulated by the amount of the food that can be procured from the graſs and green cattle crops, which can be cultivated and preſerved for their uſe during the winter ſeaſon. Without conſiderable attention to theſe different circumſtances, it muſt be impoſſible, except near large towns, where manures can be obtained at a reaſonable rate, to cultivate land to the moſt advantage.

Where the convertible ſyſtem of huſbandry is practiſed, and the ground continued for only three years in tillage, and then laid down to graſs for one, two, or more years, according to the circumſtances of the caſe, the following may be a ſuitable and proportionate diſtribution of crops for a farm of about two hundred acres.

In ſtates of graſs - - - - - - -	110	acres.
Under fallow crops - - - - - - -	30	
In grain crops - - - - - - -	60	
		200

The annual diſtribution of which may be in this way;

In the ſtate of old ſward - - - - - -	20	acres.
Under artificial graſſes, as clover, ſaintfoin, lucern, &c. -	10	
In the ſtate of irrigation or preſerved graſs - - -	5	
Under different fallow crops - - - - -	30	
Under wheat and barley, in ſucceſſion to the fallow crops	30	
Firſt year's crops of different graſſes - - - -	25	
Second ditto - - - - - - - -	25	
Third ditto - - - - - - - -	25	
In oat and other grain crops after breaking up the graſs	30	
		200

It is not to be ſuppoſed that the above method can be exactly followed in every caſe ; as circumſtances may ſometimes require a larger proportion of the land to be under grain, and at others under graſs or green cattle crops, according to the facility with which manure can be obtained, or as live-ſtock is more the object of the cultivator.

In the well-cultivated parts of Yorkſhire, the proportionate diſtribution of crops is thus ſtated *.

On a farm conſiſting of 150 acres, ſixty of which were a dry turnip ſoil, and the remainder a mixed clayey gravel on a wet bottom.

Annual diſtribution of Crops.

Wheat - - - -	30 acres.
Barley - - - -	20
Oats - - - -	14
Meadow-graſs - - -	7
Red clover - - -	14
Paſture - - - -	45
Summer fallow and turnips - -	20
	150

On a red greet, and water ſhaken ſoil, incumbent on clay. Extent 200 ſtatute acres.

Annual diſtribution of Crops.

43 acres, wheat being	15 acres after fallow.
	15 acres after clover lea.
	13 acres after oats.
	16 acres barley after fallow.
	10 acres oats.
	14 acres beans and peas.
	70 acres paſture and meadow.
	16 acres clover.
	31 acres ſummer fallow.
	200

* Corrected Agricultural Report of the Weſt-Riding of Yorkſhire, p. 90.

On a farm, extent 78 ſtatute acres, reſtricted to ploughing more than 40 acres, which is a dry gravelly ſoil.

Annual diſtribution of Crops.

18	acres wheat.
8	acres potatoes
6	acres of oats.
8	acres of peas, cabbages, &c.
27	acres paſture graſs.
11	acres meadow loam.
78	

On a farm where the ſoil was lime-ſtone, clay, and moor. Extent 139 ſtatute acres.

Annual diſtribution of Crops.

Wheat	-	-	-	-	23 acres.
Barley	-	-	-	-	9
Oats	-	-	-	-	23
Beans	-	-	-	-	5
Meadow	-	-	-	-	12
Fallow	-	-	-	-	20
Paſture	-	-	-	-	47
					139

Grain Crops.—In the cultivation of moſt ſorts of corn crops, it is eſſentially neceſſary that the ſoil ſhould be reduced to a conſiderable degree of fineneſs, or what by writers on huſbandry is termed tilth, as where this is not the caſe they can neither be ſo well provided with nouriſhment nor be kept ſufficiently clean from weeds. There are alſo other reaſons that demand the ſuperficial parts of ſoils to be in a fine condition for the reception of grain crops, which are thoſe of the tender roots of the young plants being thus rendered more capable of eſtabliſhing themſelves perfectly in the mold, and of drawing from it a more regular ſupply of food from the more equal diffuſion of moiſture that muſt take place. Beſides, it is favourable in other ways ; the ſeed is not only more perfectly but more equally covered, in conſequence of which the vegetation of the grain is more equal and expeditious *.

* Section on Fallowing of Land.

But, independent of the ftate of the foil in regard to tilth, it fhould be in a fuitable fituation in refpect to drynefs; as where the feed is put in where there is too great a degree of moifture in the foil, it may fuftain injury by becoming rotten before the vegetative procefs commences, as frequently happens to pea and other garden crops when put in during the winter months; and where the land is in too dry a ftate at the period of fowing the grain, injury may be fuftained by the want of that degree of moifture which is neceffary for perfect vegetation. Befides, under this laft circumftance it may be more liable to be deftroyed by worms, grubs, or other infects. In thefe views the agricultor fhould therefore be equally attentive to the preparation of the land, and the ftate or condition in which it may be cropped with the greateft chance of fuccefs.

Wheat.—This is a fort of crop which, from its being capable of fuftaining the feverity of winter in moft cafes without much injury, muft be confidered of a hardy nature. Of this kind of grain there are two diftinct fpecies cultivated in this country; the fmooth or polled wheat, and that which has a rough or bearded ear. The firft fort, of which there are many varieties, is by much the moft cultivated, as it affords the fineft kind of flour; but the latter, which is frequently termed *rivet* wheat, from its being capable of yielding a large produce on the more ftiff and wet clayey fort of foil, as well as from its being lefs liable to difeafe, and injury from wet when cut, is not unfrequently grown where fuch forts of land prevail. The common wheat is moft adapted to the dry and mellow kinds of foil, but may be cultivated on others where proper care is taken to keep the moifture from ftagnating too much on the land *.

* It is obferved by Mr. Boys, an intelligent cultivator in the county of Kent, that the number of forts of this grain is annually increafing, by importation from foreign countries. And that the *old* forts, are the *brown* and *yellow lammas*, the *white ftraw*, *Fulham*, and the *white* or *egg-fhell*. The *brown lammas* was the fort chiefly cultivated in that county, till within thefe twenty or thirty years; but it has now given way to a variety of new kinds, as well as fome of the other old forts. He found it from experiment the leaft productive of the feveral kinds.

It is, he fays, the *common brown-ftrawed wheat*, that grows with a long jointed ear, the chaff of a dark brown colour, the ftraw long and apt to fall, the hull or bran thin, the flour very white, and the corn mellow in grinding, for which reafon it is efteemed by the millers as the beft of the old forts for their ufe. The *yellow lammas* refembles the *brown* in every refpect, except that the colour of the grain is of a yellow hue, and the chaff of a fomewhat lighter colour.

The *white-ftrawed wheat* takes its name, he obferves, from the colour of its ear; and in other counties bears the appellation of the *Kentifh white-ftraw*. It fends out a greater number of ftems from the ftool or plant than the other forts, and by that means is often a very thick crop on the land. The ftraw is generally fomewhat fhorter than that of many other forts, and not quite fo liable to fall in rainy feafons.

It

The bearded or rivet kind is likewife faid, by fome cultivators, to be the moft fuited to fuch kinds of rich land as have been newly broken up, where there may be danger of the crop lodging from too great luxuriance, as it poffeffes the property of a greater firmnefs of ftraw.

Among the numerous varieties of the fmooth or polled kind of wheat, the white and the red are the moft efteemed in general; the former affording the whiteft flour, while the latter has the greater produce.

There is likewife another fort of this grain that may probably be cultivated to advantage in particular cafes, as where the turnip fyftem is much practifed,

It is on thefe accounts much fown in the eaftern part of that county; but, from its dull colour, its having a thick bran, and often grinding very fteely, is not much approved of by the millers.

The *Fulham*, it is alfo obferved, produces a white ftraw, which grows fhort and coarfe: it is very productive, efpecially on poor land; but the grain is very coarfe, and the bran thick: from which circumftances it is the leaft valuable to the millers of any of the above kinds.

The *white*, or *egg-fhell wheat*, is known by its producing a white ftraw, a fmooth white chaff, and very white grain; the bran of which is fomewhat thick, but the flour remarkably white. It works mellow in grinding, is very early ripe, and fo free in the ear as to blow out in windy weather.

The *new* forts of wheat in that county are the *hoary white*, the *nonpareil*, the *pilbeam*, the *fquare-ear*, and the *hoary brown*. The *hoary white*, by fome called the *velvet-eared*, is by far the moft valuable, becaufe it is very productive, and the beft for the millers' ufe. The ftraw is white and fhort, the chaff covered with a thick fine down, fomewhat of a brownifh hue; the grain remarkably fmall, and of a dull white colour; the bran very thin, fo that fome grains are almoft tranfparent when held up to the light. It grinds very mellow, and makes a beautiful fine white flour. From the quantity of down upon the chaff, and its fmall ears binding up very clofe in the fheaf, in a rainy feafon it is apt to vegetate very freely in the field; on which account it is not fo proper to cultivate in a moift climate, and in fmall inclofures that are not open to the winds and fun.

The *nonpareil* is a fort faid to be brought into this country from America; it has a bright ftraw with a brown ear; and the grain is very white, large, and plump. It is very productive on all foils, thrafhes very free, and yields, in that operation, the greater part of its chaff; thereby producing a great quantity of horfe-meat. It grinds very mellow, and is well efteemed by the millers.

The *pilbeam* is a brown wheat, growing very ftiff, and is generally thick on the land. The grain is fmall and plump, fomewhat of a yellow brown. It is faid to be very productive on rich lands, and is a valuable kind to mix with others, but will not of itfelf make good bread, from its not working properly in the act of fermentation.

The *fquare-eared wheat* is a very productive kind; but is apt to drop out in the field before it is ripe, and in gales of wind, from which it is not much cultivated.

The *hoary brown* is but lately introduced, and therefore little known.

There are two forts of *rivet wheat*, the *white* and *brown*; neither of which are much cultivated in Kent. They both ripen late in the feafon, and are fo coarfe and fteely as to be unfit for making bread, unlefs mixed with a large proportion of a better fort of flour. They, however, produce very abundant crops on ftrong wet lands.

or other ſorts of green vegetables produced on an extenſive ſcale for the winter ſupport of animals, and where the ſituation is warm and early. This is the kind known to farmers by the name of *ſpring wheat,* from the circumſtance of its being put into the ground at that period. The culture of this ſort has, however, hitherto been introduced only in a partial manner.

This kind of grain is found from experience to ſucceed in general to moſt advantage on ſuch ſoils as are of the more deep, ſtrong, and fertile nature, but where the ſuperficial parts are not ſo ſtiff or adheſive as to be incapable of falling down or breaking into a fine ſtate. It may however be grown on the lighter deſcriptions of land, and in many inſtances afford good crops, though it has been well remarked by a practical writer, that, when introduced on ſuch ſoils as are very light, whether of the ſandy, gravelly, or chalky kind, a practice too common in moſt diſtricts where they prevail, great loſs muſt be ſuſtained in a national point of view from ſuch lands being more adapted to the production of other ſorts of crops *.

Wheat is the ſort of grain moſt generally ſown where the land has received the preparation of a complete ſummer fallowing ; but it is probable that, except in particular kinds of land, as thoſe of the ſtiff clayey nature, and under particular circumſtances, as where they are moiſt, and have much tendency to the throwing up of weeds †, it may be grown to equal, if not more advantage, after many different kinds of green root and other crops. In this way it may be ſown after clover, tares, peas, beans, turnips, potatoes, and many ſimilar crops, according to the quality and ſtate of the land. In diſtricts where the flax and hemp culture is practiſed, it may likewiſe in ſome caſes be put in after ſuch crops.

But in whatever method, or after whatever kind of crop, this ſort of grain may be cultivated, the ſoil ſhould conſtantly undergo that degree of preparation that may be ſufficient, according to the particular circumſtances of the land, to bring it into a ſtate of conſiderable pulveriſation and mellowneſs, eſpecially in the more ſuperficial parts, as well as to prevent as much as poſſible the riſing of weeds ; for, whoever has attended to the progreſs of this ſort of crop in ſuch lands as have been well broken down and reduced, and in ſuch as have been left in a lumpy crude ſtate at the time of ſowing, will have found the difference to be very conſiderable. When this kind of crop is taken after clover, the land ſeldom undergoes more than one ploughing, which is moſtly given immediately before

* Donaldſon's Modern Agriculture, p. 277.

† Section on Fallowing of Land.

the feed is fown. But as the graffy matter in many cafes, where this mode is adopted, is extremely apt to rife and injure the crops in the more early ftages of their growth, it may be better to follow the practice adopted in fome diftricts of ufing a fkim-coultered plough *, as by this contrivance the remains of the clover weeds and graffy material on the furface may be cut or fkimmed off, and turned into the bottom of the furrow, where they are immediately covered with the loofe mold from below, to fuch a depth that little or no inconvenience can be fuftained from them, while the land is thus rendered more clean and capable of being harrowed in a more perfect manner than where the common plough only is employed. Befides, perhaps a better bed of mold is turned up in this way for the feed to vegetate in, provided the furrow is not made of too great a depth and breadth, and remain fome time before it be fown, which fhould conftantly be attended to by the agricultor in preparing this fort of ground for wheat crops. But it is the cuftom of fome places † where the land is often continued for nearly two feafons in the ftate of clover, to break them up about the latter end of June, in the fecond, giving them two and fometimes three ploughings. Where the fituation is favourable, and the weather turns out fuitable for reducing the foil to a proper ftate of tilth, this may be an advantageous practice, as by fuch means great benefit may be obtained by cutting the grafs in the beginning of the feafon in which it is to be ploughed up ; but where circumftances of fo favourable a nature do not occur, fuch a method of preparation muft be lefs beneficial than that of giving only one ploughing.

It has been juftly remarked, by an agricultor of confiderable experience, that in cafes where the clover crops have been fuch as to leave the land in a foul condition in refpect to weeds, it would be highly improper to fow them with this fort of grain, as from its remaining for fuch a great length of time upon the ground, they may be liable to have their feeds perfectly evolved and brought into the ftate of vegetation. In fuch cafes he fuggefts it as more advantageous to have recourfe to fuch forts of crops as may require the frequent operation of hoeing during their growth ‡.

Wheat crops fometimes fucceed thofe of the pea kind ; but this is a practice that may probably be purfued with the moft propriety and fuccefs in thofe diftricts

* This purpofe may be effected by any common plough, to the coulter of which an iron fin or plate is attached by means of a fcrew or rivet, at the diftance of about four inches from the point.

† This is the practice in the counties of Norfolk and Warwick, according to the author of Modern Agriculture.

‡ Middleton, in corrected Report of Middlefex.

that are from the nature of their ſituation ſufficiently early to admit of the land being fully cleaned and prepared by repeated ploughing and harrowing after ſuch crops have been removed, before the proper time of ſowing ſuch grain. But where they are ſo late as only to allow of the land being prepared by one ploughing before the period of ſowing, it is ſuppoſed by ſome to be an extremely hazardous practice to attempt the culture of wheat after ſuch crops, as, unleſs the ground be in a high ſtate of tilth, there is little chance of a good crop being produced *.

It is the regular practice of ſome counties to cultivate beans and wheat alternately on the ſame land for ſome time. This is the caſe on the ſtronger kinds of ſoil in the county of Kent, on which it is found to anſwer in a very beneficial manner. And where wheat is only occaſionally ſown after ſuch crops, as is the caſe in many diſtricts, it is alſo frequently found an uſeful practice; but in all ſuch caſes the beans ſhould be cultivated in drills at from twenty to thirty inches diſtance, in order that they may admit of being hand and horſe hoed in the moſt perfect manner. If this method has been followed, and the buſineſs of hoeing during the growth of the crops effectually performed, the land may be ſufficiently prepared for the ſucceeding wheat crops by once ploughing, as the ſoil, from being thus kept clean, and in high tilth, can ſcarcely fail of affording a good produce.

In the more early diſtricts, and where the lands are preſerved in good order by judicious modes of cropping, wheat may alſo be grown after beans, whether cultivated in the drill or broadcaſt ſyſtem, with ſucceſs, as there may be ſufficient time to give the neceſſary preparation before the period of ſowing, which cannot be the caſe, as has been ſeen, where they are late, and there is only time for once ploughing †.

In other places it is however found advantageous when this ſort of crop is to be grown after either peas, beans, or tares, to plough the land in as light or ſhallow a manner as poſſible, and then harrow and rake out the roots and weeds, ſo as that they may be conſumed on the ground in heaps; the field being after this formed into proper ridges for the reception of the ſeed by ploughing again a few inches deeper than at the firſt. And in ſome caſes it is even harrowed after the ſecond ploughing, and ploughed a third time ‡.

Wheat is occaſionally cultivated after turnip crops; and which may in many caſes be practiſed to advantage on the heavier turnip ſoils, eſpecially where they

* Modern Agriculture, vol. II. p. 273.

† Donaldſon's Modern Agriculture, vol. II.

‡ Middleton's Report of the Agriculture of Middleſex, p. 166.

have been kept clean from weeds by repeated hoeing, and conſumed upon the land at ſuch early periods as to admit of the ground being prepared by once ploughing in a light manner. The late crops on the lighter ſorts of land may be more properly managed by ſowing them with ſpring wheat, or leaving them for barley, for either of which they may be prepared by two or three ſhallow ploughings. Spring wheat in this mode of preparation has, in ſome caſes, been found to approach that of the autumnal ſowing.

Where the turnip crops are late, and cannot be conſumed in ſufficient time for the land to be prepared ſo as that the ſeed may be put in before December, it is probably the moſt ſafe method to let it remain to be ſown in the ſpring, as by ſuch means there will be an opportunity of getting the ground into a proper ſtate of preparation for the reception of the ſeed, which could not otherwiſe be the caſe. And under ſuch circumſtances it is undoubtedly the moſt advantageous plan to employ that ſort of wheat which is uſually known by the name of *ſpring wheat*, as from its early nature it is more adapted to be ſown at ſuch a ſeaſon.

Where this ſort of crop is intended to be cultivated after potatoes, which, as they have a great tendency to lighten the ſoil in a very great degree, as well as to exhauſt it, ſhould never be the caſe on the lighter ſorts of land in backward ſituations, or under any circumſtances where a ſufficient proportion of manure has not been applied for the potatoe crops, one light ploughing immediately before the ſeed is put in may be in moſt caſes an adequate preparation, as where proper attention has been beſtowed in the culture of ſuch crops, the ſoil is generally left in a ſufficiently fine condition.

It has, indeed, been obſerved by an intelligent cultivator, that the cauſe of wheat not ſucceeding well after potatoe crops in many inſtances is, that, beſides the land being rendered too light and porous by the growth and cultivation that are requiſite for them, the wheat is more expoſed to the injurious attacks of the grub, earth-worm, and other inſects; and in ſome expoſed ſituations, from the ſeed-time being too long protracted, the practice becomes obviouſly improper *.

In ſituations where flax and hemp are grown, this kind of grain may frequently be cultivated to advantage after them; in which circumſtances, as weeds are apt to riſe, it is always proper that the land ſhould be ploughed over two or three times, in order that a fine ſtate of tilth may be produced. The cuſtom of giving but one earth after ſuch ſorts of crops can ſeldom or ever inſure an abundant produce.

Experience has ſhewn, in the moſt clear and ſatisfactory manner, that this ſort

* Middleton, in Report of Middleſex.

of crop ſhould never, where it can be avoided, be grown after other kinds of grain crops, as rye, barley, or oats; and that the manure ſhould not be applied for it, but for ſuch crops as may precede it *. Where the contrary practice is adopted, the crop is not only liable to be injured by the rampant growth of weeds, but from its being more apt to be diſeaſed.

Whatever the nature of the ground may be, or the kinds of crops that precede this ſort of grain, it would ſeem that the preparation ſhould always be ſuch as has a tendency to reduce the ſoil to a pretty high degree of pulveriſation, as under ſuch circumſtances the vegetation of the crop is not only more perfect and uniform, but from the evenneſs of the ſurface, and compact ſtate in which it is left, is more fit for affording ſupport and protection to the roots of the plants, by allowing them to ſpread and extend themſelves with greater readineſs in the fine mold thus provided, as well as by its falling down more cloſely about them. It has, notwithſtanding, been maintained by ſome agricultors, probably without ſufficiently attending to the ſubject, that a rough or cloddy ſtate of the ſurface is the moſt proper condition for the reception of this ſort of crop, as the young plants are thereby better guarded againſt the effects of the ſevere cold that frequently occurs in the winter ſeaſon. It is probable, however, that cold is ſeldom hurtful in any great degree to this ſort of grain, except where combined with too much moiſture, or where ſudden froſts and thaws have the effect of rendering the ſuperficial parts of the ſoil ſo light and open as to be incapable of affording a proper ſupport for the roots of the young plants.

Time of ſowing.—The exact periods at which this ſort of grain may be put into the ground with the greateſt chance of ſucceſs, under different circumſtances of ſoil and climate, have not yet, ſo far as we know, been fully aſcertained by experiment. In addition to the obſervations that have been already made in ſpeaking of ſowing in general, it may, however, be uſeful to remark, that the earlier the ſeed of the autumnal ſowings can be put into the ſoil, the greater chance the young plants will have of being well eſtabliſhed in the ground before the froſts take place, which we have juſt ſeen to be a circumſtance on which the welfare of the crop in a great meaſure depends. Beſides, the ſtate of the land, and that of the ſeaſon, is much more favourable for the proceſs of vegetation when the crop is put in at an early period, than when it is delayed to a late one; the ſtate of the weather in the latter caſe often admitting of only a very languid and imperfect growth until the ſpring, by which the crop muſt be ex-

* Middleton's Report of the Agriculture of Middleſex.

poſed to much danger from various cauſes. Indeed experience has abundantly ſhewn that late ſown wheats ſeldom ſucceed ſo well, or afford ſuch plentiful crops, as thoſe that are put in early. But when ſown too early, there may notwithſtanding be danger of the crop running too much to ſtraw, and conſequently of the grain proving light in the ear. From the beginning of September to the middle, or even the end, of October, may probably be conſidered as the moſt favourable period for this buſineſs. This is, indeed, confirmed by the eſtabliſhed practice of the moſt correct farmers in almoſt every diſtrict of the kingdom, where this ſort of grain is grown *. If ſown earlier, eſpecially on the heavy kinds of ſoil, the land is for the moſt part in too hard and lumpy a ſtate to allow of the ſeed being properly covered by the harrow; and in the lighter ones in too dry a condition for the grain to vegetate in a proper manner; and, when delayed later, the ground, in one caſe, is apt to become too wet and cloſe by the falling of the autumnal rains, and in the other too looſe and porous from the action of the froſts on it. It is remarked by the writer juſt mentioned, that more than four-fifths of the whole of this ſort of grain is ſown between the middle of the firſt and the end of the laſt of the above months.

There are, however, circumſtances that may render the times of ſowing different from the above; as where the ſoils are of the rich, fertile, loamy, chalky, or gravelly kinds, it may be better to defer it in many inſtances to a conſiderably later period, as when ſuch warm ſorts of land are cropped too early, they are apt, it is ſaid, to puſh the plants forward in ſuch a rapid manner, that they become weak and ſpindling in the early ſpring months; and at the ſame time the crops are more liable to be infeſted with weeds, on account of the ſeaſon being then more favourable to their growth †.

The practice of putting in crops of this ſort ſo late as the latter end of November and beginning of December frequently depends on the crops that precede them not being capable, from the lateneſs of the ſituation, or other cauſes, of being taken off ſo early as that the land may be made ready for the wheat crop in the proper time. This is often the caſe after peas, beans, tares, turnips, and other ſimilar crops. In theſe caſes, on the lighter ſorts of ſoils, and where drill culture is employed, it may often be a more adviſable practice to ſow in the ſpring, as by ſuch a delay the ground may be brought into a more perfect ſtate of preparation than could be the caſe in ſowing it ſo late in the winter. When this method is adopted, that ſort which is known by the name of *ſpring*

* Modern Agriculture, vol. II. p. 275.

† Banniſter's Synopſis of Huſbandry.

wheat may be the moſt proper, though it is evinced, by the ſucceſs of experiments in ſowing at this ſeaſon, that any of the white thin-ſkinned ſorts of wheat may be employed, not only with ſafety, but with the proſpect of affording a good produce *.

Seed.—The quantity of ſeed that is to be made uſe of in different caſes we have already ſeen to depend upon and be regulated by a variety of different circumſtances, but in general from two to three buſhels, according to the ſtate of the ſoil, the nature of the climate, and the period in which it is put into the ground, may be eſteemed the moſt ſuitable proportion for ſoils of a medium degree of fertility, under the broadcaſt method of huſbandry; but where the drill ſyſtem of culture is practiſed, a conſiderably leſs proportion may be ſufficient for the purpoſe, as has been explained in a more full manner in ſpeaking of the nature of ſowing, or putting different ſorts of grain crops into the earth.

On the rich ſoils of Glouceſterſhire, the quantity generally ſown has been ſtated to be about ſeven pecks; while in many other diſtricts, as Yorkſhire, it is from eight to twelve †. Where the lands are in a ſuitable ſtate of tillage for receiving crops of this grain, ten pecks have been adviſed by a practical writer as the medium proportion ‡. Larger quantities are likewiſe frequently ſown in the northern parts of the kingdom ||; but it is obvious, that, where ſuch large proportions of ſeed are made uſe of, the plants muſt be liable to be drawn up too much, and the crops in conſequence to become weak and imperfectly fed, as well as ſmaller in the ſize of the ears. There may alſo be diſadvantages from making uſe of too ſmall proportions of ſeed, from the ground not being properly covered with plants: but where care is taken in the after-culture of the crops, leſs danger is probably to be apprehended from this than the other extreme, as a great number of plants will be ſupplied by the tillering or ſhooting out of new ſtems from the joints about the ſurface, in conſequence of the mold being laid up againſt them. On this account the drill method of culture may be the moſt proper when this ſort of grain is raiſed upon light ſoils that are in a ſtate of ſufficient cleanneſs, as well as from its affording a more looſe and penetrable earth for the coronal roots to ſtrike and be formed in. The broadcaſt method is, however, that which is the moſt commonly employed, eſpecially on the heavy kinds of land, whether of the clayey or loamy deſcriptions, the ſeed being caſt over the ſur-

* Exter, in Bath Papers, vol. IX.

† Marſhall's Rural Economy.

‡ Donaldſon's Modern Agriculture, vol. II.

|| Corrected Reports of Mid Lothian and Perthſhire.

face of the ground ſoon after the laſt earth or ploughing has been given by the hand, and immediately harrowed in by the lighter kinds of harrows. There is, however, another practice that prevails in ſome diſtricts, which is that of ſowing the ſeed in a partial manner, one portion being turned in by the ſecond or third ploughing, and the other afterwards harrowed in. This method would ſeem to be attended with an additional expence, without any adequate advantage being derived from it; and if great care be not taken to turn the ſeed in with a very ebb or light furrow, eſpecially in wet ſeaſons, and where the land is of a heavy and retentive quality, inconvenience may be ſuſtained by much of the grain being deſtroyed before the proceſs of germination is effected. Beſides, there muſt be great inequality in the growth of the crop, a circumſtance which we have ſeen to be injurious to the welfare of the wheat. After the ſeed has been put in, the land ſhould conſtantly be laid as dry as poſſible, by the conſtructing of proper drains and water-furrows.

After-culture.—The manner in which the crop has been put into the ground, the ſtate of the land, and the preparation on which it was ſown, may produce ſome differences in the culture that is neceſſary while it is growing. In every caſe it muſt, however, be kept perfectly clean and free from weeds, either by means of the horſe or hand-hoe, as they not only injure the crop in its growth, but leſſen the value of the ſample at the market. But the ſtirring of the mold on the ſurface among the plants may frequently be uſeful in other intentions beſides that of preventing the growth of ſeed weeds; for, as in the heavy kinds of ſoil, that are moſt adapted to this grain, the more ſuperficial parts are liable to become ſo hard and baked as not to be eaſily penetrated by the new-formed or coronal roots of the plants in the early ſpring months, eſpecially when they are very dry and have been preceded by much wet, the looſening of the earth, by any means whatever, muſt be of conſiderable utility. This effect is generally ſhewn to have taken place by the appearance and progreſs of the crop, which becomes of an unhealthy yellow colour, and advances but little in its growth. In ſuch caſes it has been ſuggeſted that harrowing once, or oftener, in a place, may be of much ſervice in the early ſpring months *. Where the crops are thin and of feeble growth, this operation may produce beneficial effects, by affording a ſort of earthing-up to the weak plants, and thereby promote a more vigorous growth, at the ſame time that a number of new ſhoots are ſent off from the joints thus covered, and the crop, in conſequence, rendered more full and abundant; and

* Middleton's Report of Middleſex.

where the grain is too thick upon the ground, it may alſo be uſeful by drawing out and deſtroying many of the plants. It has likewiſe been ſuſpected by an acute writer, that many of the root fibres, by being torn in the operation, may prevent the over luxuriance of the ſtem and leaves, and by that means promote the more early fructification of the plants *.

Rolling the land, either without having recourſe to the harrow or after it has been employed, eſpecially where the ſurface is cloddy, and the operation is performed when the ground poſſeſſes a medium degree of moiſture, may be of utility in the ſame way, as well as by forcing the roots of the wheat into the earth, and by that means cauſing new ſtems to riſe †. On all the light thin ſoils, when this ſort of grain is cultivated upon them, much benefit may alſo be produced by the uſe of the roller, by the roots of the plants being thereby prevented from being ſo eaſily looſened and thrown out of the ground. And the ſame practice is recommended as generally uſeful where clover or graſs ſeeds are ſown with wheat crops, as a means of rendering vegetation more ſecure ‡.

The former operation may likewiſe be practiſed with advantage, in the way of preventing the deſtructive ravages of the worm ‖.

In caſes where the land is not in a ſufficient ſtate of fertility or preparation to bring the crops to perfection, it may be neceſſary to make uſe of top dreſſings. Subſtances of both the ſolid and fluid kinds have been made uſe of for this purpoſe; the firſt conſiſt chiefly of the dung of different ſorts of birds after being brought into a powdery ſtate, bone-duſt, ſoot, peat, aſhes, and various ſaline matters. The latter are principally the drainings of dung-hills and other ſimilar liquid materials. The former ſhould be thinly ſown over the crops, with as much evenneſs as poſſible, as early in the ſpring as horſes can be admitted upon the land without injury; and if it can be done when the weather is inclined to be moiſt, it is the better. A roller may then be paſſed over the crop with advantage. Where the latter ſubſtances are made uſe of, care ſhould always be taken that the plants be not injured by having too large a quantity of ſuch fluids applied to them.

The practice of tranſplanting wheat may be had recourſe to in particular caſes, probably with beneficial conſequences, as where there are ſome parts of ſuch crops too thickly ſet upon the ground, while others are too thin, irregular, or patchy; as by thinning and ſetting out the plants of ſuch over-abundant parts among thoſe that are deficient, much ſervice may be done to each of them. The

* Darwin's Phytologia, p. 292.

† Ibid, p. 293.

‡ Corrected Report of Middleſex.

‖ Synopſis of Huſbandry, p. 63.

firft will be rendered more capable of admitting the operation of the hoe, and thereby of fupplying more abundant nourifhment for the luxuriant vegetation of the plants; and the latter be fupplied with the proper number of plants, which could not be accomplifhed in any other way. It has been fuggefted, that, when cultivated in the garden, one acre would be capable of affording fets for an hundred, when planted after being properly divided, at the diftance of nine inches from each other; and as the bufinefs of tranfplanting is to be performed in the fpring, it is fuppofed that crops of this grain may be raifed in this manner on lands that poffefs a greater degree of moifture than is fuited to the healthy growth of wheat in general. Befides, clean crops may be produced in this way with much greater certainty, as where the ground is ploughed over juft before the plants are fet out, the grain may rife much quicker from the plants than the weeds from their feeds, and the crop, in this way, overpower fuch noxious plants *. Many advantages of other kinds have been ftated by other writers as the refult of this practice †.

The feeding of wheat crops, where too forward or luxuriant in the early fpring months, by means of fheep, is a practice that has been found of much benefit in many cafes. The good effects in fuch inftances are fuppofed to arife from the removal of the upright central ftems, by which means different new lateral ftems or root-fcions are fent off or brought forward with more vigour, by the acquifition of a larger proportion of nutritious matter from the joints in confequence, that muft otherwife have been exhaufted in fupporting the central ftems ‡.

This practice has been found by experience to be the moft ufeful on fuch ftrong and fertile lands as are apt to produce a larger proportion of ftraw than can be properly fupported. In thefe cafes advantage has frequently been derived by feeding off the blade at two or more fucceffive times; but in managing the bufinefs, great care is neceffary to fee that the whole is completed before the crop begins to fpindle, otherwife more injury than good may be produced. But, on the lighter and more poor defcriptions of foil, the practice muft be employed with great caution, as on fuch lands the growth of the crop may be fo retarded as to become weak and fpindly. Befides, on thofe lands where they are very light, and the crops thin, injury may frequently be done, by many of the plants being pulled up on account of the clofenefs of the bite of the fheep. They fhould therefore never be fuffered to remain upon the crops when the weather is wet and the furface of the ground much loofened, or after fudden frofts and thaws; as in

* Darwin's Phytologia, p. 291.

† Bogle, in Bath Papers, vol. III.

‡ Ibid.

ſuch caſes much harm may be done by the plants' being pulled up and deſtroyed. The treading of the animals may, however, be of great ſervice in all the light ſorts of land, and where the crops are thin, as by that means the earth will not only be preſſed more cloſely about the roots of the plants, but the ſtems in many inſtances ſo forced into the ground and covered up, that new ſhoots will be ſent off laterally, and the crops be thus rendered more full on the land. But where the ſoils are very ſtiff and adheſive, the growth of the crops may be checked and retarded by the practice, and of courſe the ſhoots thus cauſed become weak, affording only ſmall ears and light grain *. The obſervation and experiments of the ſame writer have indeed fully convinced him that wheat ought not to be fed down with ſheep, unleſs it be very rank in January, and that ſuch crops ſhould only be fed as were ſown early.

But though this practice has much relation to that employed in gardening, of ſtopping the growth of the main ſtems of ſome ſorts of plants, as thoſe of the cucumber and melon kinds, by rubbing off or cutting away the central buds, in order to expedite their fruiting; yet, in wheat crops, where the principal ſtems are eaten down, except when they are early and of very luxuriant growth, the ears of the new ſhoots may not have time to perfect their ſeed, and of courſe become light and ſhrivelled in the grain; and the new ſtems, from their weakneſs, be more apt to fall down and be lodged. Theſe are circumſtances that have been frequently obſerved to occur in the feeding down of wheat crops by means of ſheep †. The ſame philoſophical writer alſo ſuggeſts that, in reſpect to the culture of wheat crops, the moſt beneficial method is that of promoting as much as poſſible the time of bloſſoming, while that of ripening is protracted ‡, as it is for the farinaceous reſervoir of nutriment depoſited in the cotyledon of the new ſeed, in order to ſupport the growth of the *corculum* or freſh embryon, that the plant is cultivated; which farinaceous depoſition is effected in the interval between the bloſſoming and ripening of the corn, either before the impregnation of the pericarp or ſeed-veſſels, or afterwards; and the weight and plumpneſs of the grain is thus augmented.

The eating down of crops by ſheep may therefore often be hurtful, by retarding the period of bloſſoming, as well as by reſtricting the growth of the ſtems ‖.

But beſides the advantage derived from the feeding down of wheat crops with ſheep, they may ſometimes be employed with benefit in other views; for

* Bath Papers, vol. I. p. 66.

† Tull's Horſe-hoeing Huſbandry, 4to. edit.

‡ Tull's Horſe-hoeing Huſbandry, 4to. edit. p. 147.

‖ Darwin's Phytologia, p. 144.

as the coronal parts of the roots of ſuch crops are liable to be laid bare and expoſed for ſome inches in length, about the ſurface of the earth, during ſevere froſty winters, the turning in of ſheep upon them in ſuch circumſtances, when the ground is moiſt, and keeping them in motion, may tend to preſs them into the looſe ſoil, and in that way produce new roots, as well as afford covering and protection to ſuch as have been denudated.

It is likewiſe a practice with ſome farmers, who contend that much advantage is derived from it, to turn ſheep upon the crops where danger is apprehended from worms, ſlugs, or other inſects; in order that, by keeping them conſtantly in motion, ſuch animals may either be wholly deſtroyed, or ſo fixed in the ſurface mold as to cauſe their more gradual death *.

There are many inſects that are highly injurious to wheat crops in mild and open winters, as well as during the ſpring, and ſometimes in the early ſummer months, by eating off and deſtroying the ſtems at the joints about the ſurface of the earth, which are in ſuch parts ſweet and tender, from their containing a portion of ſaccharine matter, and being of young growth. In theſe caſes the blades of the wheat plants drop down and become withered, by which the crops are frequently in a great meaſure deſtroyed.

The principal of theſe deſtructive animals does not yet ſeem to have been deſcribed with ſufficient correctneſs by writers on agriculture †; it is, however, probable that there may be different varieties of the ſame grub, that may be hurtful to grain crops. One kind of grub is aſſerted to be annually found in wet ſituations in larger or ſmaller quantities, according as the preceding ſeaſon has been hot or cold: and that while it continues in the ſtate of egg it cannot be injured by any ſeverity of weather that may occur. Even in the grub ſtate it is not capable of being much injured; and when in that of the fly it is equally hardy. The only period in which it appears to be ſuſceptible of injury, is that of its tranſmutation from the grub to the *aurelia* ſtate, in which ſtage it is capable of being deſtroyed by cold and wetneſs; and as this change moſtly takes place ſome time about the end of May, or in the early part of June, at which times rain generally falls in abundance, the whole, except ſuch as have ſecured themſelves in dry hills of mold, in meadows, or the borders of ditches, are annually killed. On arable lands few or none are believed to eſcape to effect the

* Corrected Report of Middleſex.

† It has been ſuggeſted by the author of a paper in the twenty-fifth volume of the Annals of Agriculture as belonging to the genus *tipula*.

purpofe of propagating their kind, unlefs in fuch feafons as are unufually droughty during the time of their change into the aurelia ftate *. Hence the rains that fall at fuch periods are not only beneficial in promoting the crop but in deftroying this fort of infect.

Befides this, it is obferved in the fame work that there are feveral other grubs brought forth at all feafons in dry lands, which are not lefs injurious to corn crops than that juft defcribed. They equally poffefs the power of refifting the hurtful effects of the weather in every ftage but that in which they are changed into the aurelia ftate, when moifture and cold has the power of readily deftroying them. The whole of the grubs that are produced on foils of the more dry kind are faid to be of the moth tribe.

It is added, that the grub, when the autumn has been mild and warm, is brought into exiftence about the latter end of October, and proceeds in its growth as long as vegetation continues in any degree; after which, probably from the want of food, it feems to remain at a ftand till the fpring feafon, when its ravages foon become evident. It begins to increafe in fize towards the end of February, and continues to grow till the early part of May, when it is often more than an inch in length, and one third of an inch or more in circumference. It is faid to be then extremely deftructive, eating through the roots of the ftrongeft ftems of corn plants in a very quick manner. And it is ftated, that on taking one of them, and putting it into earth, confifting of a foft black loam, about mid-day, covering it well, at the root of a plant of oats that had fent out thirty-feven off-fets, and which had been well earthed up, the plant, on being examined about the fame time the fucceeding day, was found to have its leaves hanging down in a declining ftate, and the root, with the whole of the off-fets, fo injured as to be utterly incapable of recovery.

In mild feafons, that are favourable for the propagation of grubs, they become numerous and highly detrimental; but, as has been juft obferved, they moftly perifh annually, the race being preferved only by the depofition of ova in the borders of ditches, plantations, and coarfe fogged herbage, in which the *aurelia* is protected from injury by moifture.

It has been found that the grub commits its principal injury on corn crops juft after the germination or fprouting of the grain, by devouring or eating away the young fhoot before it fhews itfelf above the ground. When the plants are up above the furface, and have acquired confiderable fubftance, there is much lefs danger from the ravages of thefe animals, except where they are very nu-

* Farmer's Magazine, vol. II. p. 365.

merous. During the day they are ſaid to be moſtly found from half an inch to an inch and a half below the ſurface; and they are not ſuppoſed to come much above the ground during the night *.

Various means have been ſuggeſted for the purpoſe of deſtroying theſe animals, and preventing their ravages on grain crops; but hitherto probably without much ſucceſs. The ſubſtances that have been chiefly employed in this intention are lime and ſaline matters †; but it is probable that neither of them are fully effectual in preventing the deſtructive ravages that are often experienced from ſuch animals, as it has been found by experiment that the mixing of ſuch materials, eſpecially the lime with earth, by which it is ſoon ſaturated, does not prevent them from propagating and continuing in the mold ‡, and conſequently has but little effect in preſerving crops from their attacks. But though lime, when combined with the mold of ſoils, ſo as to become perfectly effete by the abſorption of carbonic acid both from it and the atmoſphere, may not have much power in deſtroying the grub; there can be little doubt, that when applied in its cauſtic or moſt active ſtate, it will prove deſtructive to it, as well as moſt other animals of the inſect kind. It has indeed been remarked, that both hot lime and alkaline ſalts are capable of deſtroying ſuch noxious inſects as feed upon the roots, ſtems, and leaves of field plants, by the property they poſſeſs of combining with and reducing the organiſation of their bodies ||. This effect would not however ſeem to be produced on living animals, except where ſuch ſubſtances are laid on in very large proportions, by which the crops would be in danger of being deſtroyed. It is added by the ſame author, that neutral ſalts may often be made uſe of with ſucceſs in the ſame intention.

Theſe are ſuppoſed to produce their deſtructive effects on ſnails, ſlugs, grubs, and other ſimilar animals, by cauſing ſuch exceſſive evacuations, by their powerful action, that they are incapable of withſtanding them. In this view it is probable that, in the neighbourhood of the ſea, ſuch ſand as has been conſtantly for a long time covered by the tides might be employed with advantage in the way of a top-dreſſing where wheat or other crops are injured by ſuch animals. But
Sand when either cauſtic lime or ſea ſalt is laid on in the way of top-dreſſing for grain crops, in order to deſtroy the grub, when exiſting at their roots, immediately below the ſurface of the ground, great care ſhould be taken that they be not

* Annals of Agriculture, vol. XXV, p. 407.

† Of the latter kind are *ſoapers' aſhes, bleachers' aſhes, refuſe pot-aſh*, &c.

‡ Annals of Agriculture, vol. XXV. p. 406.; Darwin's Phytologia, p. 362.; and Farmer's Magazine, vol. II. p. 365.

|| Dundonald's Connection of Agriculture with Chemiſtry, p. 136.

poffeffed of fuch caufticity, or applied in fuch quantities, or fo unevenly, as to hurt the young plants by their too powerful operation on them.

Soot is likewife a faline fubftance that has been much made ufe of in different diftricts for fowing over young wheat and other grain crops when injured by worms, grubs, or other infects that feed upon and deftroy the tender ftems, leaves, and roots of fuch plants. It is a material which, in addition to carbonaceous and earthy matters, confifts of mineral or refinous oil, made capable of folution in water by the large proportion of faline fubftance which it contains. The folution thus formed, it is afferted, " is an extremely bitter, high coloured, oily liquor, which not only poifons the infect on which it may fall, but alfo communicates a bitter tafte to the furface of the roots and leaves of plants, thus rendering them unfit for the food of fuch infects *." But the effects of this fubftance may be ufeful in other ways befides that of deftroying infects; the growth of the plants may be fo quickly promoted by the bituminous oily folution formed by the faline principle of the foot, as to allow no time for the ravages of the infects on them †.

It has alfo been fuggefted, that where the grub is prevalent, rolling the land in the early fpring months, foon in the morning, may have a tendency to crufh and deftroy them: and that where the fly is found to abound, and come out in the fummer evenings on the grafs lands or fallows, it is probable that, by rolling at that time, the return of it into the earth, as well as the depofit of the ova, may be prevented, and the future propagation of the infect be guarded againft ‡.

As the ova of this deftructive animal is found to be chiefly depofited in the long grafs on the fides of hedges and ditches, it has been propofed, as a fure mode of preventing the propagation of the grub, to keep the tops of ditches and hedge-fides perfectly clean, and free from the coarfe long herbage with which they are ufually covered ‖. And, on the fame principle, the keeping of clover ftubbles clofely eaten down by fheep or other animals, after the hay has been taken, till the wheat crop is nearly ready to be put in, has been found in fome meafure an effectual remedy againft the deftructive attacks of this infect §.

Befides grubs, there are other infects which fometimes commit depredations on grain crops. One of thefe, which is believed to be the *thrips Phyfapus* of Linnæus ¶, is found to attack the late bloffoming ftems on their coming into flower, on which account early fowing may be the moft effectual remedy.

* Dundonald, on the Connection of Agriculture with Chemiftry. † Ibid. p. 138.

‡ Darwin's Phytologia, p. 369. ‖ Farmer's Magazine, vol. II. p. 365.

§ Annals of Agriculture, vol. XXV. ¶ Tranfactions of Linnæan Society, vol. III.

But, in addition to the attacks of thefe animals, wheat crops are often expofed to injuries of other kinds, fuch as the mildew, blight, blaft, and fmut.

The firft of thefe vegetable difeafes is frequently found to affect wheat and other crops, in their more advanced ftages of growth, in fuch feafons as are wet and gloomy, for fome length of time together, without much fun. The nature of this *mucor mould,* or *mildew*, feems not yet to have been fully inveftigated by writers on hufbandry; but, from the obfervations contained in an ingenious paper in the feventeenth volume of the Annals of Agriculture, there appear to be two varieties of it, the *black* and the *red*. Various conjectures have been entertained by writers concerning the caufe of the difeafe; the moft probable of which feems to be, that it is a plant of the *fungus* kind, which, like others of the fame fort, is capable of proceeding in its growth in clofe fhaded fituations without much change of air, and which by its roots penetrates the veffels of the plants to which it attaches itfelf, but which were probably, however, previoufly in a morbid condition.

As moifture, and a confined ftate of air from fhade or other fimilar caufes, have obvioufly much effect in producing the mildew in wheat and other grain crops, it feems not improbable that the beft method of preventing or removing it would be that of not having the plants too much crowded together, but thin and open, fo that light may be fully admitted, and a free circulation of air take place among the plants. This may be the moft perfectly accomplifhed by the corn being fown in rows, with fufficient diftances between them. Therefore, on lands that are fubject to mildew, the moft advantageous method may be that of fowing the grain by means of the drill, and not too thickly in the rows. Where the difeafe is prefent, the moft advifable method, in order to its removal, may be that of thinning out the weakeft plants as much as poffible, that more air and light may be let in, and by that means the ftrength and vigour of the crop be increafed, and the difeafe eradicated.

It has, indeed, been lately fuggefted, that, "as the greater dampnefs of fome land fupplies one permanent caufe of mildew, as well as its being too much overfhadowed by thick foliage, the methods of prevention muft confift in properly draining the land, and ufing drier kinds of manure, as coal afhes and bone afhes *, as well as by thinning the crops." And it may be advifable, in the fame view, "to fow early in the feafon, for the purpofe of procuring forward crops, as this difeafe is faid more to injure late crops, owing to the greater dampnefs of the ground in autumn †."

* It would probably be better, and certainly more economical, to make ufe of bones in the ftate of a coarfe powder.

† Darwin's Phytologia, p. 121.

The *blight* * is an affection of the vegetable kind that not unfrequently attacks wheat crops in feafons that are more than ordinarily moift. It has been found, that, in this difeafe, the green blades and ftalks are befet with fmall fpots of a black or rufty colour, before the ear becomes affected; and that after the grain has begun to fhoot, and is fairly come into ear, many of the heads are often completely empty; but, in fome cafes, only empty in the upper half, the under remaining perfectly full. In others again, the ears are found to have alternately a plump well-filled *pickle* and an empty hufk; and that in fome, though not quite empty, they include only fhrivelled imperfect grains, or what are termed *hungry pickles* by dealers. In different inftances ears are obferved, that are partly hungry and partly filled in a proper manner; and that in a large proportion, there is an hungry and well-filled grain alternately: in fhort, that various ears, that appear well filled, on opening the hufks are difcovered to be covered with fpots of a black and rufty caft. A number of the ftems are in fome inftances met with that are perfectly withered their whole length. When ripened, the crop, in particular cafes, is obferved to have a dirty fpotted appearance, as if fprinkled with foot, rather than the ufual clean healthy yellow afpect; and the parts of the ftraw, or ears, that are not thus fpotted, are neither white nor yellow, as is ufual, but of a colour of the dufky or afh kind †.

Thefe appearances, which fhew themfelves in the different ftages of the blight, are fuppofed, by the fame author, to prove the exiftence of an infect as the caufe of this vegetable difeafe ‡; and that as the greateft injury is almoft in

* The *uredo frumenti* of fome writers.

† Somerville in Communications to the Board of Agriculture, vol. II. p. 207.

‡ In the paper juft mentioned, which contains much valuable obfervation refpecting the nature of the blight, an infect that produced much injury to the ears of the grain is thus defcribed. It bears, fays the writer, a ftriking refemblance to a *loufe*, and when it is firft diftinguifhable by the eye, is of a red colour, nearly refembling that of a boiled lobfter, and fo foft and tender as to be killed by the flighteft preffure; as it increafes in fize, the colour gradually changes from red to a dirty black, when it becomes ftationary, and continues fo till it dies. During its growth, it alfo lofes this foft tender texture, and in its black ftate feels hard, and as if it were covered with a cruft or fhell upon the back. It does not appear that this is a new infect, for moft of the farmers with whom the writer has converfed feem well acquainted with it, and all of them affert, that, if they are carefully looked for, fome of them may be met with, even in the beft fields of wheat, every year. It appears, however, that they are infinitely more numerous and deftructive in late wet feafons, than in fuch as are earlier and more favourable. In the year 1782, for inftance, when the crop was uncommonly late, and the feafon very wet and cold throughout, the wheat crop, he fays, almoft entirely failed from the depredations of this infect; and every other inftance that can be recollected of their mifchievous effects, has always taken place in the lateft and coldeft feafons. The obfervations

every case done to such crops as have not been perfectly covered after sowing, or when the seed is very near the surface, while such as are deposited to a greater depth almost wholly escape, it is suggested, that, by depositing the grain more deeply in the soil, and covering it in a more perfect manner, as by drilling or dibbling, much may be effected in the prevention of this malady.

Others, however, consider the disease as a fungus of the linear, oblong, tawny, black kind, that attaches itself to the stems of the wheat plants at the period when the grain is nearly ripe, in such seasons as are very moist, affording a sooty appearance to the crop. It is asserted, that the stems are apparently split, and the growth of the plants greatly impaired and restricted *. The author of Phytologia supposes it to be a malady in some measure similar to the *rubigo*, or *rust*, a disease that attacks particular plants that are previously in an unhealthy condition, and which may probably be prevented, or remedied, by the exposure of them to more light, and a greater degree of ventilation, as in the mildew or white *mucor*.

Some also assert the cause of this affection to be a vitiated state of the juices of the vegetables proceeding from obstruction, induced by sudden alternations of heat, cold, and moisture, without sufficient sun to cause the absorption of the latter, in consequence of which insects are generated in the plants, and their growth thus injured; and, on these grounds, advise similar modes of removing it

which he made a few summers ago confirm him in that belief: for he uniformly found that, in proportion as a field of wheat was early, the injury done was not only much less, but the number of vermin smaller; while, on the contrary, as the crop was later the mischief was in the same proportion greater, and continued so throughout the season. The inference he draws from thence is, that wet seasons are more favourable to the generation of these insects than dry ones, and that though they are bred in considerable numbers even in the best years, yet they come into existence at a period of the season when the crop is too far advanced to be injured by them. This last idea was considerably strengthened by trials which he lately made, of placing the insects upon healthy plants at different periods of their growth: when put upon plants in the flower, and while the stalks and blades were green and tender, they adhered firmly, and completely effected the destruction of the ear; but when put upon such as had made some progress towards filling the blades, and the stalks of which were beginning to harden and become tough, they not only entered upon them with more difficulty, but if the growth and filling had advanced beyond a certain period, and the blades, &c. had lost their saccharine taste, they would not remain upon them; or if they did, they died, seemingly of hunger. He tried them upon several hundreds of healthy ears in this way, and with the same result; from which he thinks it is at least presumable, that a certain degree of hardness in the stalks and husks of the wheat is a sufficient protection against this insect; and that after the grain has past the milky state, it is beyond the reach of being injured by them.

* Lambert, in Transactions of Linnæan Society, vol. IV.

to thofe that have been mentioned above *. It is well obferved that the blights occafioned by froft generally happen in the fpring, when cold nights fucceed to warm funny days, as the living power of the plant has then been previoufly exhaufted by the ftimulus of heat; and is therefore lefs capable of being excited into the actions which are neceffary to vegetable life, by the greatly diminifhed ftimulus of a freezing atmofphere. But whether the malady originate from infects, the action of other plants, a corrupted ftate of the vegetable fluids, or fome peculiar defect in the vegetative procefs of the plants, it is probable the beft mode of preventing or removing it will be the expofure of the plants as much as poffible to the influence of the air, by fowing the grain with larger fpaces, or thinning them out, when too thick and clofe, by the hoe, in the later fpring months, when the ftate of the crop is fully afcertained. That fuch methods may be beneficial, is clearly fhewn by the general obfervation, that hilly diftricts are much lefs expofed to the difeafe than fuch as are low, flat, and confined.

The *blaft* is an affection of vegetables that proceeds from lightning, or the intenfe action of the fun, when the plants are in a ftate of confiderable aptitude for the action of ftimuli. It is the moft common in hot climates; but Dr. Darwin, from having found that extenfive wood-cutters often find trees cracked on being fawn through, fuggefts lightning as a more frequent caufe of the difeafe in this country than is commonly fuppofed. The effects of thefe caufes on wheat crops have been noticed by Tull, and defcribed as occurring in blackifh patches in different parts of the fields. As the vital power of the plants is moftly, in thefe cafes, either completely exhaufted by the great and fudden operation of fuch ftimuli, or their vafcular fyftem deftroyed by their expanfive action, no remedy can be of any great utility †.

The *uftilago*, or *fmut*, is another vegetable difeafe to which wheat and other grain crops are often expofed, and in which a fort of black meal is produced in the place of feed. It has been afcribed to many different caufes by writers on agriculture. It is remarked in the Memoirs of the Bath Agricultural Society, that this is a difeafe that only occurs when the weather is wet during the period of flowering, in which the *anthers* may burft, and the *farina* be wafhed away. The difeafe is there fuppofed not to be produced by any infectious fubftance, or the ova of infects that may adhere to the grain, as fmutty ears and found ones were found proceeding from the fame root, and, in fome inftances, both fmutty

* New Farmer's Calendar, p. 408. † Darwin's Phytologia, p. 352.

and ſound grains to be contained in the ſame ear; ſome of the corns having even one end ſmutty and the other ſound. It is therefore ſuppoſed to ariſe in conſequence of the want of due impregnation, from the *farina fecundans* being faulty, and that putrefaction takes place on the death of the corn. This opinion is ſupported by the experiments of Spallanzani, who diſcovered that the ſeed is produced in the plants long anterior to impregnation, which cannot be performed until the flower is open, and the duſt of the anther fully ripe.

On theſe grounds, it is conceived that, for want of impregnation, or the vivifying principle, the wheat corn may putrify, as is the caſe with the addle eggs of oviparous animals*.

The enquiries of a writer who ſeems to have paid much attention to the ſubject, are, however, highly in favour of the opinion, that the malady is produced by the attacks of an inſect; and that, though unqueſtionably infectious, it may be prevented, or cured, by the uſe of different kinds of ſteeps, ſuch as have been already deſcribed †. Others have likewiſe ſuggeſted that ſteeps, prepared with aloes, tobacco, and hellebore, may be uſeful for the ſame purpoſe, when applied during the growth of the crop, by means of a piece of flannel immerſed in them, and drawn different ways of the ridges, by two perſons walking in the furrows, ſo as to touch the ears ‡. The proper time of performing this buſineſs is when the weather is fine and dry ||.

* Darwin's Phytologia, p. 323.

† Communications to the Board of Agriculture, vol. II. p. 226. || Ibid.

‡ The facts and obſervations on which theſe concluſions are founded, are detailed in the following manner by Mr. Somerville, in the ſecond volume of Communications to the Board of Agriculture. Some years ago, he ſays, he collected a quantity of ſmutted ears from one field of wheat, in which they were very numerous, and a number of healthy well-filled ears from another field, in which there was no ſmut. The grains were rubbed out of both, intimately mixed, and kept in a box for two months, at the end of which they were rubbed between the hands in ſuch a manner as to break the whole of the ſmut ball. The parcel was then divided into two equal parts, one of which was three or four times waſhed with pure water, and well rubbed between the hands at each waſhing, and afterwards ſown in a drill in his garden; the other half was ſown in another drill without any waſhing or preparation whatever; the ſoil and every other circumſtance was equal. Both parcels vegetated at the ſame time, and for about two months thereafter there was no viſible difference in their appearance; about that period he, however, obſerved that many of the plants in the drill, that had been ſown without being waſhed, were of a darker colour than the others; theſe, when narrowly examined, were of a dirty green. The plants in the drill that had been waſhed were all of one colour, and ſeemingly healthy; as the ſeaſon advanced, the difference in colour became more ſtriking, and continued to increaſe till the grain was fairly out of the blade; about which time many of the dirty green ears began to exhibit ſymptoms of decay. As ſoon as the ear was fairly ſhot out, the whole of thoſe in the un-

But though thefe methods may be employed in order to prevent the propagation of the difeafe, it is probable that it can only be effectually guarded againft by fowing the feed in fuch a manner as to admit of a perfectly free circulation of air among the plants, and of thofe modes of after culture that are adapted to promote their healthy and vigorous growth.

wafhed drill, that had the dirty green appearance above defcribed, were found to contain nothing but fmut; and thefe fmutted ears were in the proportion of more than fix to one of the healthy ones: while, on the contrary, the drill in which the wafhed grains had been fown, and which confifted of feveral hundred grains, had hardly a fmutted or unhealthy ear in it. The fame experiment was repeated the following feafon, and with nearly the fame refult. Satisfied with knowing that complete wafhing would be found a remedy for the difeafe, he made no farther enquiry upon the fubject till laft autumn, when he was employed in making obfervations upon the blight, in the courfe of which he met with a good deal of fmut in many fields; and being at the time poffeffed of fome excellent glaffes, he carefully examined fome of the fmutted plants. This at firft was done more as a matter of amufement, than from an expectation of difcovering any thing that might contribute to throw light upon the fubject. Upon a near infpection with the glafs, he found that the dirty green colour of the blades of the fmutted ears was owing to a number of fpots infinitely fmall, and bearing a near refemblance to thofe upon blighted ears: his obfervations were continued throughout the whole period of the ripening, in the courfe of which he made no additional difcovery, except obferving, that the leaves and ftalks of the fmutted ears decayed fooner than fuch as were healthy.

About the end of autumn, however, having one day brought home fome fmutted ears of rather an unufual appearance, he examined them very narrowly, and obferved that the balls were perforated in many places with fmall round holes, a thing he had not before obferved in any that he had met with: this he afcribed to vermin; and upon fticking one of the grains upon a pin, and placing it under the glafs in a very bright fun, he could diftinctly obferve feveral fmall tranfparent fpecks upon the beard, or downy part of it. He examined feveral more, and met with exactly the fame appearance; but being called haftily away upon bufinefs, he was under the neceffity of leaving them upon the table, without being able to afcertain whether the objects he had feen were eggs or infects. In the evening when he came home, he refumed the inveftigation by *candle-light;* in the courfe of which, as he was under the neceffity of holding them very near the candle, the heat foon relieved him from his embarraffment, by putting them in motion, and he then difcovered that the fpecks above mentioned were real infects, refembling wood-lice in fhape. Next day he repeated the fame trials by fun-light with new fmut-balls, and difcovered the fame appearances, but without being able to make any of the infects ftir. Difappointed and vexed at not being able to fee them in motion with fun-light, and recollecting the heat of the candle, he threw the concentrated rays of the fun upon them with a burning-glafs, which completely anfwered his purpofe of putting them in motion, and fhewing them in every different point of view. To defcribe minutely an infect fo fmall as not to be diftinguifhable by the naked eye, would, fays he, be no eafy matter; it is fufficient to fay, that its general appearance is very fimilar to the wood-loufe, though infinitely fmaller.

As foon as he was clearly afcertained of the exiftence of this infect, his mind was, he fays, perfectly at eafe with regard to the caufe of the diftemper; but though he could very readily conceive

It has been ſuggeſted that grain diſcoloured with the ſmut may be readily rendered proper for ſale by waſhing and drying it upon a malt kiln, as the ſound corn is ſome time in ſaturating itſelf with moiſture. Sand may alſo be uſed for the ſame purpoſe, which, after being mixed and well agitated with the grain, may be ſeparated by means of a ſieve *.

There are particular ſtates of the weather that have conſiderable influence on the wheat crops at particular periods of their growth. When the ſeaſon is ſufficiently dry, there is ſeldom much injury done to them during the winter months, however ſevere they may be in other reſpects; nor in thoſe of the

that vermin, in the early ſtages of the growth of a plant, might ſo injure the ſtamina as to render it unfit to produce any thing but ſmut, he could not ſo well underſtand how it was poſſible for the mere touch of the black earth contained in the ſmut-balls to produce the ſame effect.

After ſome reaſoning he, however, gives it as his opinion that ſmut is occaſioned by the ſmall inſect above deſcribed, as ſeen by the glaſs in the downy part of the grain; and that when the balls are either broken in the operation of thraſhing, or come in contact with clean healthy grains, the inſects leave the ſmutted grains, and, adhering to ſuch as are healthy, are ſown with them, and wound the tender ſtem in ſuch a manner as to render the plant incapable of producing any thing but ſmut. It is not an eaſy matter to account for the manner in which this takes place; but a little attention to the circumſtances he is now to mention will perhaps throw ſome light upon it. It is known that plants of very oppoſite *natures* and *qualities* will grow and produce abundantly upon the ſame ſoil, where the nouriſhment is ſeemingly the ſame. This effect is alſo known to be owing to the ſtructure of their veſſels, by the action of which the juices that circulate through them are differently prepared in every different plant. From this ſtriking difference, owing confeſſedly to organiſation, is it not, ſays he, preſumable that the ſmut in wheat is produced by the inſects wounding the veſſels of the plant in ſuch a manner as to render them incapable of taking up any other principle from the ſoil, but the ſmut contained in the balls, which upon examination ſeems to have no quality different from the fineſt vegetable earth? This opinion he thinks is ſtrongly ſupported from the circumſtance of certain *pickles* being found a cure for the malady. The effect of theſe pickles is, however, completely miſunderſtood; for in place of ſuppoſing, as is erroneouſly done, that they operate by ſtrengthening the grain, and thereby removing that debility which has been long conſidered as the cauſe of ſmut, their benefit depends upon the powers they poſſeſs of deſtroying the inſects above deſcribed: but to ſhew the abſurdity of the commonly received opinion in a more ſtriking point of view, it is only neceſſary, he adds, to ſtate, that many of theſe preparations, which are ſuppoſed to be ſo friendly to vegetation, are in fact highly inimical to it, unleſs they are uſed with the utmoſt caution; even ſtale urine, which has long been conſidered as a ſafe and innocent remedy, is, under certain circumſtances, highly pernicious. After he had diſcovered the inſect, he made trial of all the ſubſtances commonly uſed, and found all of them, when properly applied, deſtructive to it. Is it not therefore, continues he, more agreeable to plain common ſenſe to ſuppoſe, that the virtue of theſe preparations conſiſts more in the power they have of deſtroying vermin, than in any ſtrengthening quality they poſſeſs?

* Phytologia, p. 323.

ſummer, provided the weather is not too moiſt about the blooming ſeaſon, as where that is the caſe the crops are moſtly deficient *.

There are ſeveral different ſorts of weeds that become injurious to wheat crops, where they have been put in upon lands in an imperfect ſtate of preparation. On the lighter kinds of ſoils, eſpecially thoſe of the calcareous deſcription, *charlock* † is often extremely troubleſome. It is a weed that bears a yellow flower in ſome of the kinds, and a white one in the other, and is not therefore one individual plant, as generally ſuppoſed by the moſt part of farmers, but three diſtinct ſpecies, each of which is prevalent in different places. Theſe are the rough-leaved charlock, or wild muſtard; the ſmooth-leaved, or wild rape; and the rough-leaved wild radiſh having white flowers ‡. They are all annual plants, ariſing from ſeeds which they afford in great abundance, and which, if ſuffered to be ſhed upon the land, remain for a great number of years enveloped in the clods, in a condition fit for vegetation on expoſure to the influence of the air, and a ſuitable degree of moiſture, by means of ploughing, or any other method of breaking up and reducing the ſoil. Such plants ſhould, of courſe, never be permitted to run to ſeed, but be extirpated in their young ſtate, either by hoeing or ſome other means; as, by attention in this way, much inconvenience may be avoided, as the increaſe by ſeeding is hardly to be conceived. Bindweed is alſo a weed of the paraſitical ſort, that is highly injurious to wheat crops on this ſort of land. It is of two kinds, the common and the black ||, and may be removed with greater eaſe than the above, by affording ſufficient tillage.

The *corn poppy* § is another weed that is often injurious to theſe crops on the chalky ſorts of land. It moſtly makes its appearance about May, proceeding with ſuch rapidity in its growth, both in height and laterally, as ſoon to overtop the grain, and deſtroy the crop, by the ſhade that it produces, the corn being rendered thin and defective in the ear. In theſe caſes it is the cuſtom of ſome diſtricts to obviate the miſchief by eating the weeds in the early ſpring, as about May, by hogs, which are ſaid to be ſo particularly fond of the plant as to devour it with avidity, and in preference to the young wheat ¶. The practice

* Synopſis of Huſbandry.

† It is often, beſides this, known by the different names of *cadlock, kitlock, kilk,* in particular diſtricts.

‡ The *ſinapis nigra*, the *braſſica napus,* and the *rephanus raphaniſtrum*, of botaniſts.

|| The *convolvulus arvenſis*, and the *polygonum convolvulus,* of botaniſts.

§ The *papaver rhoeas* of botanical writers.

¶ Synopſis of Huſbandry, p. 78.

feems, however, dangerous, and a better and more fafe remedy is at hand in due tillage of the land, and the early extirpation of the plants by the hoe.

Cockle * is likewife a weed that often proves hurtful to crops of wheat. It is of great increafe, frequently fending off feveral ftems from the fame root, each containing many pods filled with feed. It ufually blows about June, with a pink-coloured bloffom, and may then be eradicated without much difficulty, by pulling up the plants as they come up. There are two forts of this weed, the common and ear cockle. The latter, according to a late practical writer, varies from the former, in being confiderably fmaller in fize, and by its peculiarity of growing within the ear of the wheat plant; in fome inftances the whole ear affording no other produce than this, while, in others, one part of it contains perfectly formed wheat, and the other ear-cockle. It is afferted, on the authority of much obfervation, to be a degeneracy in the wheat, from its being too frequently fown on the fame land from which it was produced †. If this be the fact, the remedy muft obvioufly confift in a frequent change of feed. It is, however, more probable that this weed is produced by fowing the feed with the wheat, and may of courfe be prevented by care in fowing clean wheat.

White darnel ‡ is another very prolific weed that does much injury to wheat crops, both during the time of its growth, and when at market, by fpoiling the fample. It is an annual plant, the ftem of which has a flight refemblance to that of grain, and may probably be beft prevented by attention to the putting in fuch feed wheat as is perfectly clean. Where it occurs, the fafeft method is to draw it out by the hand.

Puck-needle ‖ is a weed that is often abundant on fuch lands as are hard tilled, and almoft equally injurious with the above in leffening the value of the fample at the market. As the feed of this weed is not eafily feparated in cleaning the corn, much care is always neceffary in order to prevent its being fown with the feed.

Couch, or what in many diftricts is better known by the name fquitch, is a weed that is highly injurious to wheat crops, and extremely difficult and expenfive in its removal to the cultivators of fuch arable lands as thofe defcribed above. It does not comprehend the roots of any one particular, but of feveral forts of peren-

* The *agroftemma githago* of writers on botany.

† Bannifter's Synopfis of Hufbandry.

‡ This is the *lolium temulentum* of botanifts, and is often known to farmers by the names of *drake* or *droke*.

‖ The *fcardix pecten veneris* of botanifts, and what is often known to agriculcors by the names of Shepherd's needle, Beggar's needle, &c.

nial graffes, efpecially thofe of the bent kind, the dog's grafs, the creeping foft grafs, the tall oat grafs, &c. * The roots of thefe different graffes are not unfrequently, in fuch lands as have been exhaufted and worn out by improper tillage, fo interwoven with the foil, and in fo matted a condition, as to obftruct the progrefs of the plough. They are found to be moft abundant in the lighter and more mixed kinds of foil. Weeds of thefe kinds are only capable of being completely removed and deftroyed by having them drawn out, while the land is under fallow, by means of heavy harrows conftructed for the purpofe, with a greater number of teeth, or tines, than is neceffary for thofe of the common fort, and placed fo as to incline more forward. When brought into heaps in this way, they may either be confumed by fire, or reduced into a compoft, by the incorporating of lime, in its unflaked or moft cauftic ftate, with them, and afterwards adding dung, or rich mold, in a fuitable proportion. The latter is by much the moft economical method when lime can be readily procured, and is not attended with much trouble, as fuch compofts may be formed in the corners or other parts of the fields where the weeds are produced. The ufual method of picking out the roots by hand labour, which is termed *couching*, is not only tedious and expenfive, but feldom effectually performed. The well-known property of thefe roots to propagate and encourage different forts of grubs, worms, or other infects, affords a ftrong inducement to effect the deftruction of fuch root weeds by every poffible means, efpecially where wheat crops are to be grown.

Befides thefe weeds, there are others that are equally hurtful to wheat crops in lands that have not undergone a proper preparation by tillage, and are rather ftrong and moift, fuch as the corn-crowfoot, the tare, &c. †. In grounds where the latter predominates, care fhould conftantly be taken to deftroy it, by reducing them into a ftate of fine tilth before the wheat is put in.

Coltsfoot ‡ is a weed that, in foils of the moift and rather heavy kinds that have been confiderably exhaufted by tillage, is liable to become troublefome, and of great difadvantage to the wheat crops. As this weed begins to fhew its flower towards February and March, and foon afterwards ripens its feeds, it fhould not by any means be neglected at fuch periods, as from the levity of them, and their downy nature, they are quickly conveyed to a diftance, by which means they foon eftablifh themfelves in different places. Repeated ploughings

* The *agroftes*, the *triticum repens*, the *holcus mollis*, and the *avena elatior* of botanical authors.

† The *ranunculus arvenfis* and *croam tetrafpernam* of botanifts.

‡ The *tuffilago farfara* of writers on botany.

during the fummer feafon, by rendering the foil light and mellow, may render them capable of being more readily extirpated by weeding. And as they delight in moifture, laying the foil more dry by the forming of proper drains may alfo be of great utility. But from the roots of the plants fpreading themfelves extenfively near the furface of the land, they will conftantly require to be completely extirpated.

Wheat is known to be ripe and ready for the reaper, by its ftraw turning of a yellow colour, its ears beginning to bend in the neck and hang down, their having no greennefs in the middle of them, and the grain becoming hard and plump. The quantity of wheat produced upon the acre muft vary confiderably, according to the circumftances of foil and preparation, as well as the ftate of the feafon; for it has been found, that fome years the yield is under twenty while in others it is upwards of thirty bufhels the acre, the foil and culture being in every refpect the fame *. The average return of this crop throughout the whole of the kingdom, is probably not more than from three to three and a half quarters. A practical writer has, indeed, ftated it at not more than three †.

In Middlefex, the greateft crop of wheat of which the author of the Report of that diftrict has any account, is, he fays, fixty-eight bufhels per acre; the leaft about twelve. The medium between thefe extremes is forty, which, he thinks, would be the average of land highly conditioned. But the average produce of Britain does not, he fuppofes, exceed one half of this quantity, and yet, fays he, wheat is as certain a crop as any that is cultivated ‡. This, he thinks, affords a clear proof that " the lands of England are reduced confider-

* Corrected Report of Middlefex.

† Donaldfon's Modern Agriculture, vol. II. p. 276.

‡ According to Mr. Middleton, " the proportion which corn bears to the ftraw in that diftrict, is nearly as follows; namely,

The yield of	1793	was	$17\frac{1}{2}$ bufhels of wheat to a load of ftraw;
of	1794		$8\frac{1}{8}$ ditto;
of	1795		11 ditto;
of	1796		$9\frac{3}{8}$ ditto.
The medium of four years			$11\frac{1}{2}$ ditto.

Straw fold during the fame period from 25*s.* to 40*s.* per load. The load confifts of 36 truffes, at 36lbs. per trufs. Two loads of wheat ftraw per acre is reckoned a tolerable crop, which may be averaged at eight pence a trufs, or 24*s.* a load, or 2*l.* 8*s.* per acre. In other parts of the kingdom, the

ably below par, which," in his opinion, "can only have happened by a too frequent repetition of corn crops, and general bad management, which has of courſe leſſened the *quantity* of *live ſtock*, and with that, the beſt means of raiſing *manure*. Let farmers," continues he, "be induced to ſow crops to be eaten on the land by cattle, ſo that they may there leave their dung and urine, and corn will then be grown in double quantity; and the live ſtock, ſupported by ſuch green crops, be clear gain to the community."

In order to aſcertain the goodneſs of a ſample of wheat, it is neceſſary to judge by the eye whether the *berry* be perfectly fed, or full, plump, and bright, and whether there be any adulteration proceeding from ſprouted grains, ſmut, or the ſeeds of weeds; and by the ſmell, whether there be any improper impregnation, and whether it has been too much heated in the mow or upon the kiln; and finally, by the feel, to determine if the grain be ſufficiently dry, as when much loaded with moiſture it is improper for the uſes of the miller. Where the ſample handles coarſe, rough, and does not ſlip eaſily in the hand, it may be decided not to be in a condition either for grinding or laying up in the granary. The ſame means may alſo ſerve to determine the weight; but conſiderable experience is neceſſary to decide with much correctneſs. It is obſerved by the author of the Synopſis of Huſbandry, that "it is a good ſample of wheat where the weight of a ſack, at eight gallons the buſhel in meaſure, arrives at four buſhels three and a quarter pecks in weight, or 2 cwt. 1 qr. 18lb. If," continues he, "a ſack of this meaſure weigh half buſhels and quarter, the ſample is not bad, which is 2 cwt. 1 qr. 4 lb." In the technical language of the farmer and miller, it is uſual, he adds, "to drop the buſhels, and mention only the odd weight; thus, in the firſt inſtance the wheat weighed three pecks four, and in the latter half buſhels four. If there are no odd pounds, it is ſaid to weigh half buſhels, or if from large meaſure the weight comes to 2 cwt. 2 qr. then it is ſaid to weigh five buſhels."

Rye.—This is a ſpecies of grain which probably approaches neareſt to the nature of wheat of any that is at preſent in cultivation. It has two varieties, the *winter* and *ſpring* rye, or what is often farther diſtinguiſhed into the *black*, and *white* or

value of the ſtraw is ſuppoſed equal to nearly the expence of reaping. Perhaps at an average of 30*s.* (it has lately been as high as 3*l.* 12*s.*) which is on the corn, equal per buſhel to - £. 0 2 7

Short ſtraw and chaff - - - - - -	0	0	1
Wheat, at an average price for many years - - -	0	5	6
The entire produce of wheat per buſhel, is full - -	£. 0	8	2

The weight of the wheat grown in the ſtrong land diſtrict, is uſually 61 or 62lbs. per buſhel."

Dantzic rye. The former ſort is the largeſt, and the moſt plump and hardy, conſequently the moſt frequently grown by agricultors; but the ſpring kind may often be employed with ſucceſs. This grain is ſo capable of reſiſting the effects of the weather, that, when ſown in the autumn, it is ſeldom much injured by the moſt ſevere winter. It is more early in the ſpring than wheat, and, though not equally valuable, is more certain of producing a good crop.

This ſort of grain is capable of being cultivated on moſt kinds of land, but the light dry ſandy ſoils that cannot be converted to the purpoſe of wheat or barley crops, are, perhaps, the only ones on which it can be grown to advantage, from their being the moſt adapted to it, and from few of them being ſo light or poor as not to afford good crops. It can of courſe only be introduced with ſucceſs on ſuch lands as are incapable of producing other ſorts of corn to advantage, and where the improved methods of cultivating wheat crops have not been had recourſe to. Even upon ſome of the pooreſt ſorts of ſandy ſoil, wheat is ſuppoſed in ſome diſtricts to be grown with more benefit to the cultivator, the quality of the land being the ſame, than this grain *. And from fowls being leſs fond of it than moſt other ſorts of grain, it may be the moſt proper to be cultivated on thoſe portions of ground that are ſituated cloſe around the farm houſes.

It is a kind of crop that is moſtly grown after early-fed turnips, clover, peas, and other ſimilar products, as well as after naked fallows, in particular caſes. When cultivated on the cold and heavy kinds of ſoil, the grain is much later in becoming ripe than on ſuch as are dry and light.

This crop, like that of wheat, requires the land to be in a tolerable ſtate of pulveriſation, and perfectly cleared from weeds. In many diſtricts, when intended to ſtand for a crop, it is the cuſtom to put it in upon ſome ſort of fallow; but where it is only to be fed off by ſheep, ſeldom more than one ploughing is given, the land being broken up and fallowed for turnips immediately after the crop has been ſufficiently eaten down by ſheep or other animals. It is the practice in ſome places to apply manure immediately for this crop; but where the ſoil is in a ſuitable ſtate of preparation, and has not previouſly been too much deteriorated by the growth of other grain crops, it may be more adviſable, eſpecially where it is not to be fed off, to defer the application of the manure, in order that it may be employed for the turnip or other green crop that may ſucceed it, the uſe of manure being apt to bring up weeds.

* Young's corrected Report of Suffolk, p. 57.

Time of ſowing.—The periods of putting this kind of crop into the ſoil are, in general, pretty much the ſame as thoſe of wheat; but when cultivated for green food, it may be advantageous to ſow early, as in Auguſt and September; but it may be ſown in October, and during the winter months, until the beginning of March, in particular caſes, as where the early ſowings have failed, or there is an intention of having a ſucceſſion of this ſort of feed for ſheep.

Seed.—The general allowance of feed, where the crop is deſigned to remain for grain, is in moſt ſituations from about two buſhels to two and a half; but when the intention is to feed it off, three, or even more, may be a better proportion, as the plants in ſuch caſes ſhould ſtand conſiderably thicker upon the ground, in order that the largeſt poſſible quantity of green food may be provided. As the proceſs of germination in this ſort of grain is rather ſlow, it may be adviſable to put it into the ground when it is in a tolerably dry condition, otherwiſe much of it may periſh, eſpecially in wet ſeaſons.

It was formerly a prevailing cuſtom to blend ſeveral other ſorts of feed with that of rye, and the practice ſtill continues in ſome diſtricts in reſpect to wheat and winter tares; but it is by no means either judicious or uſeful, ſince, in the firſt caſe, the rye is in a ſtate fit for reaping long before the wheat, conſequently much loſs muſt be ſuſtained; and, in the latter, it is moſtly in a condition to be cut as green food ſome weeks before the tares, and becomes ripe at much too early a period for them *.

Where wheat is combined with rye, it is in many diſtricts termed *meſlin*, the proportion of the latter to that of the former being regulated by the nature of the ſoil, and the judgment of the cultivator, the principle being that of giving the largeſt proportion of rye to the lighteſt kinds of ſoil †.

After-culture.—When this ſort of crop is grown for the purpoſe of the grain, it will be conſtantly neceſſary to keep it clean in the early ſtages of its growth by hand weeding and hoeing, when they may appear requiſite; but where the intention is merely that of affording a ſupply of green food for the uſe of ſheep or other animals in the more early ſpring months, no further culture will be wanted after the crop has been put into the ground.

This ſort of crop is known to be ready for the ſickle by the ſtraw of the ſtems becoming of a yellowiſh colour, the ears hanging down, and the grain feeling hard, and in a plump and full condition.

* Modern Agriculture, and Corrected Report of Middleſex.

† Corrected Report of the North Riding of Yorkſhire.

In the poor ſandy ſoils of Suffolk, good crops of this ſort are ſeldom afforded, and on thoſe of a better quality the produce is rarely more than from two to three quarters on the acre. But in the north riding of Yorkſhire, it is ſtated by the able author of the Agricultural Report of that diſtrict, to amount to from three to ſix quarters.

When this ſort of grain is free from weeds, and cut when the weather is fine, it may be ſecured in the ſtack as faſt as the reaping proceeds.

The ſtraw of this grain is ſuperior to that of wheat, both for the purpoſe of thatch, and for the uſe of the collar-makers.

This is a kind of grain that is alſo cultivated in particular caſes, as where the ground is ſufficiently light and dry, to be turned down as a manure; when this is the caſe, the crop ſhould always be turned in while in its moſt green and ſucculent ſtate, and when the weather is moderately dry, in order that it may be more quickly reduced by the proceſs of putrefaction.

It is ſometimes the practice of farmers, when rye is intended to ſtand for a crop, to feed it with ſheep in the early ſpring, as in the beginning of March; but this ſhould never be done except where the crop is very luxuriant, and at ſo early a period as that there may not be any danger of deſtroying the new-formed ear.

In the ſouthern parts of the kingdom it is alſo often cultivated for the uſes of thoſe engaged in the buſineſs of tanning leather; but more frequently as a green food for ſheep in the ſpring, before the turnip crops are ready. When grown in this view, it is neceſſary to have attention to different circumſtances, in order to derive the utmoſt advantage from the crops. As this grain begins to ſhoot out, or ſpindle, as it is termed by farmers, much earlier than wheat, care, as has been juſt obſerved, ſhould be taken that the feeding of it down is begun at a ſufficiently early period before the ear is formed in the *hoſe*, as the latter end of February or beginning of March; otherwiſe the ſtem or blade becomes firm and ſticky, and the ſucceſſion of green feed, after the firſt eating, extremely ſmall. Indeed this may be done earlier than the firſt of theſe periods, in caſes where the ſeaſon is mild and open, and perſevered in till the end of April. In all caſes it is, however, adviſable to let the crop be ſo advanced in its growth as to cover the ground tolerably before the ſheep are turned in. As this ſort of green food is ſaid to have much effect in promoting the flow of milk in ſuch ewes as have lambs, probably from its ſucculency, and its ſtimulant properties being applied immediately after the ſeverity of the winter ſeaſon, when the bodies of animals are known to be more capable of being excited by the action of ſtimuli; and when there is

fcarcely any other fort of green feed that can leffen its operation by being taken along with it, the culture of it muft be the moft advantageous where fheep-hufbandry is extenfively combined with that of tillage, efpecially that department of it which relates to the feeding of lambs; as by this means, from the quantity of fucculent nutritious food that is provided, the lambs are prevented from being ftinted in their growth while young, which is a matter of the utmoft importance in their future feeding.

In feeding this fort of crop off by fheep, it will likewife conftantly be neceffary to keep the fields properly divided by means of hurdles, as in this way the lofs of food will be much lefs, and fome parts will become frefh while the others are eating down.

Barley.—This is a much lefs hardy fort of grain than either of thofe that have been defcribed; but from its great utility in the compofition of malt liquors, and in the preparation of various kinds of fpirits, it is extenfively cultivated in fuch diftricts as, from the nature of their foils, are adapted to its growth. It may, indeed, be confidered as the next grain in value to that of wheat.

There are feveral kinds of this grain cultivated in particular parts of the kingdom; as the *fpring* or common *barley*, the *long-eared barley*, the *fprat* or *battledore barley*, the *bear* or *fquare barley*, and the *big barley*. The firft fpecies of barley is grown pretty extenfively in the fouthern as well as the eaftern parts of the ifland; and the fecond, or long-eared fort, may frequently be met with, but from the great length and weight of its ears, it is more apt to lodge, confequently is more hazardous than that of the common or fpring kind. The fprat or battledore fort is broader in the ear than any of the others, and has at the fame time a fhorter and more tapering ftem, with erect ears, on which accounts it is lefs difpofed to lodge or fall to the ground. It is often diftinguifhed by the title of Fulham barley, from its having been extenfively cultivated in the neighbourhood of that place. The *bear* or four-rowed barley, and the *big* or fix-rowed barley, are grown to confiderable extent in the north-weftern parts of England, as well as in Scotland. Thefe are winter barleys, and require to be put into the ground in the autumnal feafon, fomewhat in the manner of wheat.

From the tender and delicate nature of this fort of grain, efpecially in the more early ftages of its growth, it is incapable of being cultivated with advantage on the ftiff, heavy, and wet defcriptions of foil, or fuch as are of a cold and tenacious quality. It is faid to grow in the moft perfect manner in a loamy fand, or fuch foils as are moderately dry and fufficiently light. The moft plump and

thinneſt-rinded grain is aſſerted to be produced on ſuch lands as are dry, light, and mellow; and theſe are the qualities that are conſidered as the moſt eſtimable. Light poor land, when dry and warm in reſpect to ſoil and ſituation, is even capable of affording barley that is much ſuperior in quality to ſuch as is grown on ſtrong lands, that are of a cold and moiſt nature.

This ſort of grain is cultivated after almoſt every kind of crop; but it has been found to ſucceed to the moſt advantage after thoſe of the green or ameliorating kind; as turnips, potatoes, carrots, peas, tares, &c. However, from the nature of grain crops, it can ſeldom be cultivated to great advantage after wheat, rye, or oats: in ſuch caſes it has generally been obſerved that the crops were blighted and imperfectly fed, even upon ſoils the moſt adapted to this ſort of grain*. Where flax, hemp, or rape, are grown, barley may ſometimes be ſown after them. When ſown after any of theſe improving crops, manure is ſeldom neceſſary; as in many of them the ſoil muſt be rendered ſuitable by the feeding of them off by animals, and in the others, from a large proportion of it being required for the growth of ſuch crops, it muſt be equally unneceſſary. If, however, a wheat or other ſort of ſtubble be choſen for the purpoſe, manure will be requiſite, which ſhould always be well mixed and incorporated with the mold before the ſeed is put in, and be in a conſiderable ſtate of reduction before it is applied.

After whatever ſort of crop this grain may be grown, as the root is extremely tender, and requires much ſupport during the firſt ſtages of the growth of the plant, from the quick manner in which the proceſs of vegetation is carried on, the ſoil ſhould conſtantly be reduced into a ſtate of much fineneſs and pulveriſation, ſo as to become properly open and porous, in order to ſecure a more certain, equal, and perfect vegetation. This is to be effected by different ſlight or ebb ploughings and harrowings, as well as by occaſional croſs-ploughing and rolling. In very wet ſeaſons, on the heavier kinds of barley land, and where there are land ſprings, it may be adviſable to plough the ground into ſmall ridglets, of about eighteen or twenty inches in width, inſtead of leaving them flat; as by ſuch means the land may be kept dry in any ſeaſon, at leaſt to ſuch a degree that by two or three dry days it may become in a condition for undergoing the operation of harrowing, in order to the ſecond ploughing; and in caſe the ſtate of the weather ſhould ſtill continue improperly moiſt, the ground on this ploughing might be ridged up in a ſimilar way until the period of ſowing, when a few days more of fine weather would be ſufficient to render

* Donaldſon's Preſent State of Huſbandry in Great Britain.

it proper to be reduced by the harrow or fcuffle, fo as that the feed might be put in; or when the land is in a more moift ftate than is fuitable for this crop, a third ploughing may be given before the feed is put in *. It is likewife fuggefted in the fame work, that the ufing of the fcuffle, inftead of the plough, in the fecond earth, would not only expedite the bufinefs of preparation, but be a confiderable faving of expence. In foils that are free from weeds, it is afferted that fcuffling would be equal to a crofs-ploughing, and in fuch as are not perfectly clear from root weeds, it would be ftill more advantageous by bringing them within the power of the harrow; at the fame time, that it would accomplifh more than double the quantity of labour with an equal number of men and horfes, befides leaving the ground equally ready for the harrow and the roller, previoufly to the putting in of the feed.

When this fort of crop is introduced upon green fallows, fuch as turnips, &c. it is fometimes the cuftom to prepare the land only by one ploughing; but a better practice is that of giving two earths, the firft as early in the fpring as it can be done, and the fecond immediately before the feed is put in. This is the practice moftly adopted in Norfolk, where the barley hufbandry, on turnip fallows, is, in moft inftances, well performed.

In fowing this grain after peas, or other pulfe crops, it is cuftomary in moft diftricts to give the firft earth or ploughing in the autumn, which fhould always be performed in fuch a manner, as that the greateft poffible extent of furface may be expofed to the influence of the atmofphere and the action of the frofts; the ridges being at the fame time fo laid up, as that no injury may be produced by the wetnefs that may take place during the winter feafon. The fecond earth or furrow † is moftly given about March, when the oat crop has been put into the foil. By this ploughing, two different purpofes are effected in many cafes; the root-weeds, fuch as thofe of couch, and other noxious plants, may be loofened, fo as to be more readily extirpated by the application of the harrows immediately afterwards, and the foil reduced to fo fine a tilth, as that thofe of the feed kind may be induced to vegetate freely, and in confequence be more perfectly removed by the action of the plough and harrow at the period of putting in the feed ‡.

If this kind of grain be introduced after wheat, or other forts of corn crops,

* Middleton's Report of Middlefex.

† This is fometimes termed the *fteering* furrow in the northern diftricts.

‡ Modern Agriculture, vol. II. p. 282.

which, as has been ſhewn, is by no means a practice to be recommended, the preparation of the land is moſtly conducted in the ſame manner as the above.

Time of ſowing.—The period of putting this ſort of crop into the ſoil muſt, of courſe, vary in ſome degree according to the nature and quality of the land, and its ſituation in reſpect to climate. In moſt of the more ſouthern diſtricts of the kingdom it generally commences about the beginning of March, but in the northern parts of the iſland it often begins a month or ſix weeks later. The largeſt quantity of ſeed is uſually ſown from the middle of March to the latter end of April.

Seed.—The proportion of ſeed that may be neceſſary muſt be different, as the ſoil is of a richer or poorer quality, and as the ſeaſon of putting it into the earth is more early or late. The nature of the crop after which it is cultivated may alſo render ſome difference in the proportion of the ſeed requiſite. Much leſs ſeed is demanded where the ſoil is rich and fertile, than where it is poor and exhauſted. Early ſowing alſo requires leſs ſeed than where a late period is adopted. It has been obſerved, that, on a medium ſoil, in proper condition, ſown broadcaſt, the proper proportion may be in March three and a half, in April four, and in May four and a half, buſhels to the acre. Such is the difference of rich ſoils, that it is ſuppoſed that it can hardly be ſown too thin; one buſhel and a half ſown early having afforded as much as could ſtand, where, if three or four had been put in, the grain would have been lodged, and of courſe greatly reduced in its value *. After turnips, and other green crops, a much leſs quantity is generally neceſſary, as ſuch lands are moſtly in a perfectly ſuitable ſtate for the reception of barley crops. As this ſort of grain is apt to come up in an irregular manner, and of courſe to become ripe at different periods, by which means the ſample often ſuſtains great injury; it is probable, that by ſteeping the ſeed for ſuch a length of time as might be ſufficient to impregnate it with a due proportion of moiſture, the proceſs of vegetation might be rendered not only more regular, but even much more expeditious. The ſeed is put into the ſoil in different methods; being in ſome caſes ſown under the furrow, and in others above it. Where the firſt practice is adopted, the ſeed furrow ſhould be very light, otherwiſe the grain may be depoſited to ſuch a depth as to greatly retard, or even prevent, much of the ſeed from coming up in proper time. When ſown on the ſurface, great care ſhould be taken that the ſeed be well harrowed into the ſoil, and ſo covered, as that the grain may vegetate, and grow up in as equal and regular a manner as poſſible.

* Corrected Report of Middleſex.

It is the practice of many districts to sow clover, and other grass seeds, with this crop; but where the soils are very rich, and of a good quality, this method of husbandry is improper, as much inconvenience and injury may be done to the grain by the rapid and over-luxuriant growth of such crops, rendering the plants weak and imperfectly fed. On the thinner and less fertile soils, where the growth of such grasses is less vigorous, it may however be adopted with advantage in many cases, as little injury will be done to the grain, while the straw may be considerably improved in the way of fodder.

Where this mode of management is had recourse to, the sowing of the grass seeds may be deferred for some time after the grain has been sown; and when they are put in, a light harrow may be passed over them, and the land be afterwards well rolled.

The success that has attended the use of the drill and the setting of grain in particular cases, suggests the propriety of attempting similar practices in the cultivation of this sort of crop, especially on the richer descriptions of barley soils, as by such methods it seems probable that the quality as well as the produce may be greatly improved.

Though the practice of steeping this kind of grain before it is put into the ground is not in general use with farmers, it is probable, as has been just observed, that much advantage might be derived from it, especially as the season is commonly hot and dry when it is performed, from the more quick and uniform vegetation of the crop. It is likewise supposed by some agriculturs, that by mixing soot with such steeps the danger from insects may be diminished.

In the choice of seed, attention should constantly be paid to the colour and the state of the skin or rind of the grain; as that is esteemed the best which has a pale lively bright appearance, without having the tails of the corn stained in any way, and which is full and plump, or what is often termed well-bodied. It is common with practical farmers to change the seed of barley every year or two, from the supposition that the grain becomes coarser by the repeated sowing of the same kind of seed. The necessity of this custom may, however, probably arise from the neglect of making use of such seed as is full-bodied and perfectly fed and ripened.

After-culture.—As this sort of crop is mostly sown broadcast, it seldom receives any improvement by culture afterwards. It is obvious, however, that by occasionally stirring and loosening the mold about the roots of the plants, and keeping them clean and perfectly free from weeds, much advantage might be obtained in many cases in the cultivation of this sort of grain; as it may thereby

be rendered not only more abundant upon the ground, but the fample be confiderably improved.

When the feafon turns out dry and unkindly in the early fpring months, this fort of crop is often much injured by the attacks of the worm; which is obvious from the fudden change in the appearance of the plants, from a healthy green to a yellow caft. On the firft appearance of this change, the ufe of the roller fhould be had recourfe to, in order that the fuperficial parts of the foil, which are probably become too loofe and porous, may be effectually preffed, and thereby rendered too clofe and compact to admit the worm to prey upon the tender roots of the young plants. That this effect may be produced in the moft effectual manner, the roller fhould be of fuch a fize, or fo loaded, as to afford a preffure equal to the draught of three or four horfes, which fhould be yoked double, in order to increafe the effect by their treading. It has been fuggefted, that, if by this method the injury can be counteracted until fuch time as rain falls, there need not be any apprehenfion of the crop, as the plants will foon pufh forward in fuch a manner as to become too ftrong to be in danger from this infect *. It is probable too, that top-dreffings, fuch as have been recommended for wheat, fown over the crop immediately before the ufe of the roller, might be of utility in leffening the ravages of this deftructive worm. And it is found to be of the utmoft confequence to the fuccefs of barley crops, that the weather prove moift about the period in which the plants fhoot out into the ear; as where the contrary is the cafe, the crops are liable to fuftain much injury, from the want of that fupply of food which is neceffary for the perfect formation of the grain.

The produce of this kind of grain, like that of moft others, varies confiderably according to the ftate of the foil, climate, and the cultivation that is employed; but the average over the whole kingdom is probably from about twenty-feven to thirty bufhels the acre. In the county of Middlefex, according to the Report of that diftrict, the average produce is about four quarters of grain and two loads of ftraw to the acre; and in Yorkfhire, on the turnip lands the produce is nearly the fame; but in many other diftricts it does not average more than three and a half. It is ftated that, in Middlefex, the ftraw generally fetches about one guinea a load when delivered in, which, together with the chaff and thin grain, is equal to one fhilling and fix pence the bufhel on the corn; and that as the corn averages three fhillings, they produce together four fhillings and fix pence the bufhel, or feven pounds four fhillings the acre.

* Synopfis of Hufbandry, p. 91.

In ſoils where barley crops become too rank and luxuriant, as may be the caſe in very open ſpring weather, on ſuch lands as are in a high ſtate of fertility, it may often be neceſſary to reſtrict the over-vigorous growth of the crops, by either feeding them down with ſheep, or cutting them with a ſcythe as a green food for animals; the latter method is ſaid to be preferable, as by it the rank tops are only removed, while in the former the whole is indiſcriminately conſumed, and particularly the ſtems of the plants at the joints about the ſurface of the ground, where they are ſweet and nutritious from the quantity of ſaccharine matter that is depoſited in them, by which much injury may be done to the future proſperity of the crops *. It is probable, however, that, independent of this circumſtance, barley crops can in but few inſtances, from their tender nature, and the expedition with which they ſhoot into ear, be fed down by ſheep without injury; as by the mutilation of the new-formed ears, and their being much retarded in their progreſs, the maturation of the grain may be too long delayed to be effected in a perfect manner. The practice, when neceſſary, can therefore only be had recourſe to with propriety at an early period.

This ſort of grain is ſhewn to be ripe by the diſappearance of the reddiſh caſt on the ear, or what by farmers is termed red *roan*, by the ears beginning to droop and bend themſelves round againſt the ſtems, and by the ſtalks becoming brittle and of a yellowiſh colour.

Barley ſhould conſtantly remain out in the field until it be perfectly dry and free from moiſture, otherwiſe it is liable to heat in the ſtack, and the ſample be thereby greatly injured both for the purpoſes of feed and malting.

It is found by experience that the Fulham barley, which has been once ſown on ſtiff loamy ſoils, is the moſt ſuitable for the purpoſes of malting, as the ſkin is thinner, and the quantity of meal conſiderably larger. From its quicker growth it is of courſe leſs expoſed in the field to the effects of moiſture, which is known to be highly injurious to this grain, and on which the good qualities juſt mentioned may in a great meaſure depend. It is the fine white clear thin-ſkinned barleys that bring the higheſt prices at the markets, whether they be ſold for the purpoſes of malting, or thoſe of feed.

Oats.—The cultivation of this ſort of grain has of late years been conſiderably increaſed, probably on account of the greater demand for them in conſequence of the great increaſe in the number of pleaſure horſes that have been kept.

It is a ſpecies of grain of which there are many varieties in cultivation ; as

* Engliſh Encyclopædia, Art. Huſbandry.

the *white*, the *black*, the *red*, the *blue*, and the *naked* oat. There are likewiſe other varieties of this corn which are diſtinguiſhed by the names of the countries from which they have been introduced ; as the *Poland*, the *Tartarian* or *Siberian*, and the *Frieſland* oat.

The *white* oat is a valuable kind, and where the ſoil is dry, rich, and in a good ſtate of cultivation, may be grown to great advantage, as it moſtly brings the beſt price at the market, and yields the moſt abundantly in threſhing out. It is cultivated the moſt extenſively where the uſe of oat bread is general, as it affords the whiteſt meal.

The *black* oat may be grown where the land is inferior in quality : it is nearly equal in value, from its being found ſo highly nutritious as a food for cattle and horſes.

The *red* or *brown* oat is likewiſe proper for the ſtronger ſorts of land ; it is a very hardy kind, and affords a great increaſe. The grain is full and heavy, on which account it is probably to be preferred for the purpoſe of feeding animals to the above ſorts.

The *blue* oat is only cultivated in particular diſtricts. It is ſuggeſted in Miller's Dictionary as the ſort known to farmers under the title of *Scotch Greys*.

The *naked* oat is a kind that is but little cultivated, except in particular places. It has however the property of threſhing clean out of the huſk. This ſort has not, according to Ray, a hard huſk as in the common oat, but ſeveral thin chaffy coats. The grain is alſo ſmaller, but fuller in the body, and inclining to a tawny colour. It may be cultivated on the poorer ſorts of land.

The *Poland* oat has a ſhort full-bodied grain ; but it has yet been little introduced into cultivation, probably on account of the thickneſs of its ſkin or rind. The ſtraw is ſhort, the grain ſet ſingle, and without awns.

The *Frieſland* oat has a thin-ſkinned grain, and a large proportion of ſtraw. The corns are for the moſt part double, the larger of which is in ſome caſes awned, the awn being ſituated high. It is moſt ſuitable for the better ſorts of land. It is known in ſome diſtricts by the title of the *Dutch* oat.

In the *Siberian* or *Tartarian* oat the grains are thin and ſmall, the largeſt of which are awned, but the ſmall ones without awns. The ſtraw is tall and reedy, on which account it is improper for the purpoſe of fodder for cattle. It may however be grown on the poorer ſorts of ſoil.

This ſort of grain is hardy, and may be cultivated upon almoſt any kind of ſoil ; but, as in others, it is the moſt productive on ſuch as are ſtrong, rich, and adheſive, and which have been newly broken up from the ſtate of graſs. It is

ſuggeſted, that though this ſort of grain generally ſells lower than barley, yet, from its being a more certain crop, the ſuperior utility of the ſtraw for the food of cattle, and the increaſe in the quantity of produce, it is equal to barley for medium loams. And that for ſtronger ſorts of lands, and thoſe of the fen kind, it is greatly ſuperior to it, though apt to leave the land in a more foul and compact condition *. On the cold, tenacious, fenny, and wet deſcriptions of ſoils, the oat may indeed in many caſes be ſown with more advantage than any other kinds of crop, and likewiſe where lands cannot be put in a proper condition for barley crops.

Oats ſucceed well after almoſt every ſort of green and root crops, but ſhould not be cultivated after wheat, rye, or barley, where it can poſſibly be avoided, as the ſoil by ſuch cropping would be too greatly exhauſted. It has been obſerved, that, in diſtricts where improved methods of huſbandry are adopted, oats are generally grown upon ſuch lands as have been newly broken up from the ſtate of graſs, and that the practice is ſhewn to be perfectly correct, by the abundance of the produce in ſuch caſes. The cuſtom of cultivating oat crops in ſucceſſion for ſeveral years is equally abſurd and improper, and ſhould be generally exploded †.

In regard to the preparation for this ſort of crop, it is recommended by an intelligent cultivator, that when it is intended to be grown after cole, tares, early peas, or ſuch other crops as do not come off the ground later than the beginning of June, on ſoils that are too wet to admit of being ploughed in the winter ſeaſon to make a clean baſtard fallow, laying the land up into ridges proper for being ſown in the early ſpring. Or when after ſuch clean crops as come off too late to admit of baſtard fallowing, to plough only once, which ſhould be as early as the buſineſs of the farm will admit, into ridges proper for putting the ſeed in ‡.

It is remarked by Mr. Donaldſon, in his account of the preſent ſtate of huſbandry in this country, that whatever may have been the nature of the crop that preceded this, it is but in very few caſes that more than one clean furrow is afforded. In ſome diſtricts it is, he aſſerts, the common practice to plough the lands over that are intended for oats, in the autumn, in a particular manner, ſo as to expoſe as large an extent of ſurface to the influence of the atmoſphere as poſſible. This in ſome places is termed by farmers *rib-furrowing*, and in others *ſlob-furrowing*; it is performed by turning over the furrows at the diſtance of from twelve to

* Corrected Report of Middleſex.

† Modern Agriculture, vol. II.

‡ Ibid.

eighteen inches from each other on the unbroken land. In this way one half of the fuperficial part of the land remains unmoved, and the furrows being thrown on it, much furface is expofed, and the foil greatly improved, at the fame time that the root weeds are deftroyed. If this procefs be accomplifhed in the moft perfect manner, and in the autumnal feafon, the foil is confiderably ameliorated and improved by the frofts during the winter, and by being well broken down by the harrow in the fpring, having a complete ploughing immediately before the feed is put in, the foil becomes in an excellent condition for this fort of crop, even where the land is of the ftiff and heavy kind. There can indeed be little doubt but that, by the land's undergoing a more full and complete preparation than is ufual for this crop, the quantity of produce may be greatly increafed, as the fibrous roots of the plants are more enabled to extend themfelves in the loofe earth, and thereby to afford a more perfect fupport to the plants. In fome cafes, as where the land has been much reduced and exhaufted by the previous crops, or in breaking up thin poor foils where the proportion of turfy material is inconfiderable, and when the prices of other forts of grain are low, it may be advantageous to have recourfe to the ufe of manure, as by fuch means it is probable that a third more produce at leaft might be grown.

Time of fowing.—In this bufinefs it is neceffary to keep in mind that the earlier the feed is put into the ground, the fooner in general the crop will be ready to cut. In the more fouthern parts of the kingdom, it is often the cafe to put this fort of feed into the earth towards the latter end of February, when the feafon is dry and fine; but March is in general the oat feed feafon. On fuch foils as are naturally dry and parching, it is however by much the beft practice to fow early, in order that the crop may be well eftablifhed before the hot weather commences. And befides, there may be a greater chance of the grain efcaping the ravages of the worm that often attacks fuch crops; and when this infect is prefent, its ravages may be more eafily prevented. As this fort of crop is liable to be injured by very fevere winters, it can feldom be fafe to put it in in the autumn, efpecially in the northern parts of the ifland; but in the fouthern diftricts it may be done with propriety in particular cafes, as where the land is of a very dry and friable nature, large crops having been afferted to have been grown in this way in combination with tares in fome inftances *.

Seed.—The proportion of feed that may be required muft differ according to the difference of the circumftances that have been already ftated; but on foils

* Corrected Report of Middlefex, p. 187.

of a middling quality, four bufhels may be fufficient for the more early fowings, and five for the later ones, where they are put into the ground in the broadcaft method, which fhould conftantly be the cafe where the firft modes of preparation are adopted. In fome of the fouthern diftricts the *Poland* oat is fown at the rate of about four bufhels the acre for the firft fowings; and it has been found in practice that the earlieft fown crops conftantly afforded the moft perfect fample, and in general the moft abundant produce. With the oats, clover may be fown when neceffary, the feeds being covered by harrowing fuitably to the condition of the land, and where the foil is very light or mellow, a roller fhould be paffed over it as foon after as poffible, in order to prefs the mold to the feeds; but in other circumftances it may be more advifable to defer the rolling until the feafon is dry, and the crop fomewhat advanced in its growth. The practice of fowing oats under furrow, though it has been attempted on the lighter and more dry forts of land, is not by any means to be advifed, as in fuch a method the feed is apt to be depofited to too great a depth, and to be in danger of either being in fome meafure deftroyed, or of coming up in an irregular manner. The ufe of the drill has not been fo much practifed with this fort of crop as to afcertain the utility of it; nor has that of dibbling been tried with that fort of attention that is neceffary to determine the propriety of it.

As this kind of grain is fuppofed to be more liable than moft others to degenerate, by being too long continued on the fame land, it has been the practice of fome diftricts to change it for fuch as has been imported from other countries *. It is probable, however, that by collecting and fowing the beft and moft perfect of our own produce, this expenfive practice may be rendered unneceffary. By fimilar attention moft of the different forts of oats are alfo capable of being greatly improved both in the quality and appearance of the grain.

When this fort of grain is cultivated on fuch leys as are newly broken up, there may frequently be danger, efpecially where the land has been long in the ftate of grafs, both from the deftructive attacks of infects, and the foil becoming too light, open, and porous, from the decay of the graffy material, for the fupport of the plants. The firft may probably in fome meafure be obviated, by eating fuch lands very clofely with fheep previous to their being broken up, as by fuch a method the ova of fuch infects may be much deftroyed, and their propagation prevented. And the treading the crops by fheep, as well as the

* Corrected Report of the North Riding of Yorkfhire.

roller, may likewife be beneficial in both refpects. Horfes have alfo been turned in for the fame purpofe by fome cultivators *. For the above reafons, it has been fuggefted as improper to put oat crops in on newly broken up land, or even in the fecond year's cultivation of them, or what in fome diftricts it termed a *lea-breech* †. Peas and beans, according to the nature of the foil, are generally confidered as the moft proper forts of crops in thefe cafes.

It is moftly confidered by writers on agriculture as a better and more correct practice to fow grafs feeds with this crop than barley, as the tillage requifite for the latter may difpofe it to become rank and be lodged, by which the grafs will be drawn up weak through it, and in that way be greatly injured; as well as the barley, by the humidity thus produced, require a longer time in the field, and in that way be expofed to more danger in cafe of a wet feafon fucceeding, while with oats there is little rifk in thefe refpects, as the ftraw is much ftiffer and more firm. Where oat crops are thin upon the ground, they grow ftrong, and are confequently better capable of fupporting themfelves without falling on the ground.

After-culture.—The only culture that is neceffary for this fort of crop while growing, is that of keeping it as clean and free from weeds as poffible, by means of hand-weeding, and the ufe of the forceps. It is alfo a practice in fome places to pafs a light roller over the crop after it is advanced a few inches in height, when the ground has been flightly moiftened by rain; by which the cloddinefs of the furface is reduced, and the plants in fome meafure earthed up, and the progrefs of the crop not only much promoted, but, where thin, the plants rendered more thick upon the land by the tillering that is thus produced.

Oat crops are ready for the fcythe, or fickle, when the ftraw exhibits a yellowifh caft, the grain becomes hard, and the chaff opens in fuch a manner as to render it in fome degree naked. This fort of crop does not require to be fo dry when put into the ftack as thofe of either wheat or barley.

It is fometimes a practice in this fort of crop, as well as that of wheat, when there is danger of its being too rank or luxuriant in its growth, to feed it down with fheep in the fpring months. This is not, however, a method that is to be adopted, except in particular circumftances, as where there is great difficulty in procuring fheep feed at fuch periods, or where the worm is committing its ravages upon the plants; as this fort of grain is not in general apt to be injured either by the luxuriancy of its growth, or by being lodged.

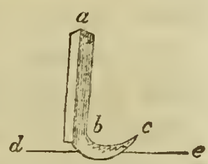
* Bannifter's Synopfis of Hufbandry, p. 101. † Ibid. p. 102.

ADDITIONS AND CORRECTIONS

TO THE FIRST VOLUME.

To be read after Line 8, *Page* 5.—It has been ſuggeſted by an able agricultor, that the breaſt of a plough ſhould be long and narrow, making an acute angle with the beam; the length of the breaſt tends to preſerve the *flag* from breaking, the ſurface for its ſupport being large. This is a very important conſideration in ploughing old leys for wheat, peaſe, &c., as a number of weeds are thus ſmothered which would otherwiſe inſinuate themſelves through the interſtices of broken ground. The reſiſtance of the earth againſt the breaſt, is alſo obviouſly diminiſhed in proportion to the acute angularity of the breaſt againſt the beam.

To be read after Line 10, *Page* 17.—On ſome very ſtiff clayey ſoils the ordinary cuneiform coulters have been found incapable of penetrating to a ſufficient depth without the aſſiſtance of extraordinary weight and preſſure. This great inconvenience has been in ſome meaſure overcome by adding to the extremities of the coulters a blade of iron to precede them, curved like an inverted ſcythe, or turned up, as it were, like the toe of a ſkate, thus: *a b* is the old-faſhioned coulter (the groove which conducts the ſeed being left blank), and *b c* is the curved knife now added to facilitate its inſertion; *d e* is intended to repreſent the level of the land.



This conſtruction of the coulters ſeems to poſſeſs the double advantage of facilitating their inſertion into the ground, and of affording ſome reſiſtance to any occaſional obliquity of direction to which the machine may be urged.

Implements uſed in the Cultivation of Hops.

To be read after Line 10, *Page* 28.—In preparing grounds for the reception of hop-vines, and in keeping them clean and free from weeds during their growth, ſeveral different implements are employed. The ſpade and the common hand-hoe are, however, in ſome places the chief tools that are made uſe of, though they obviouſly require much time, and conſequently increaſe the expenſe of the cultivator.

Hop-Shim.—This implement is conſtructed with a frame, ſomewhat in the manner of the common wheelbarrow, and has feet or teeth which cut up and drag out ſuch weeds as may be preſent at the ſame time, that they pulverize and prepare the

ground. Mr. Boys in his valuable Report of the Agriculture of the County of Kent, alſo obſerves that this implement may be advantageouſly employed for clearing ſummer fallows from weeds. When well made it coſts about two guineas.

Nidget.—This tool is formed of a triangular ſhape, and of different ſizes, according to the diſtances of the alleys in which it is to be made uſe of, with croſs bars or beams, in which are fixed a number of hoes in proportion to the breadth of the intervals between the rows of hops, ſo that its hinder part, which is the wideſt, may paſs without doing any miſchief to the binds on each ſide. The hindermoſt beam has fixed to it a pair of handles, by which the machine is directed in its operation.

The implement is drawn by one horſe, managed by a boy; and two acres may in this way be cleanſed in a day. Care ſhould however be taken, when uſing it, that in finiſhing, the alleys be all croſſed in the ſame direction, in order that every part of the ſurface, except the ſpaces which the hills occupy, may be cut over. The hills are to be afterwards rendered clean by means of hand-hoeing. It will be neceſſary to continue the uſe of this inſtrument as occaſion may require, until the branches of the hops are put forth in ſuch a manner as to prevent the horſe from going along the alleys. By this means hop-grounds may be kept clean and in order at a much leſs expenſe than by hand-hoeing, or even digging them in the ſummer.

The principal circumſtance to be attended to in the management of the nidget, is that of guarding againſt its damaging the binds by coming too near the poles.

Hop-Harrow.—By ſome hop-planters this tool is uſed after the nidget, for rendering the ground ſtill finer; it is conſtructed nearly in the form of the nidget, but with a ſmall wheel in the front, in order to go round at the ends of the plantation more readily. A pair of handles are fixed on behind, by which it is guided in the alleys, and kept from bruiſing the binds, by the perſon who holds them. Implements of this kind, when properly made, coſt from thirty to forty ſhillings.

Mr. Middleton, in his Report of the County of Middleſex, alſo ſpeaks of an inſtrument, in uſe by Mr. Maynard, for cleaning hop-grounds, which reſembles the ſnow-plough: in ſhape it is an equilateral triangle, the ſides of which are four feet long, and the front ones ſhod with old ſcythes; the whole being ſtrongly framed in order that it may be loaded when employed. He obſerves that "by drawing it once in a place, in the intervals between the rows, it renders them perfectly clean, and as ſmooth as the well-rolled walk of a pleaſure-ground, and earths up the rows by the ſame operation, which, about ten days afterwards, are eaſily made into hills with ſpades."

Peeler.—The peeler is made uſe of for forming holes for the hop-poles; it is a ſort

of iron crow, with a wooden handle acrofs at the top, and made thick and tapering, in order to remove the earth fufficiently for the infertion of the ends of the poles.

Hop-Dog.—This is a kind of lever, made of a long piece of good wood, with a fixed fulcrum, to the lower end of which is faftened a ftrong piece of iron with teeth, which grafp the lower end of the hop-pole firmly, and by the action of the lever wrenches up the pole.

To be read after Line 10, *under the Head* Chaff-Cutters, *Page* 32.—A wheel with two knives fixed on its radii will, however, it is believed, cut more ftraw in a given time, and with a given force, than a wheel with three knives; as where there are three knives one of them is always upon the ftraw; the refiftance is, of courfe, fo great and conftant, as materially to diminifh both velocity and momentum, and confequently power. Mr. Burrel, of Thetford, in Norfolk, we believe, has attached to the fide of thefe machines a crank, which, by means of a fpindle terminating in a cog-wheel, much affifts the primary force. Two boys, or women, are capable of turning this wheel for many hours together. It is probable that the application of a multiplying wheel to thefe machines would much facilitate the labour of them.

To be read after Line 15, *Page* 52.---It is alfo of importance that ftables fhould be better lighted than they ufually are; the blindnefs fo frequent among horfes has been attributed with confiderable plaufibility to an exceffive ftimulus of light on their coming out of a dark ftable, where the irritability of the organs of fight has been for hours accumulating, into the full glare of day. Farm ftables, during the fummer feafon, are very generally expofed to the open air; the door or wicket is feldom fhut but at night: In confequence of this expofure, flies, which are attracted by the horfe-dung, &c. have free accefs. It will generally be obferved, however, that, in fuch expofed ftables, cobwebs alfo are very numerous: it is unwife to difturb them; the fpider fhould be cherifhed, as he faves the horfe from the irritation of many troublefome enemies. The provifion is natural, and fhould be attended to.

To be read after Line 4, *Page* 67.—On the mode of applying fuel in the firft inftance, and fteam in the fecond, to culinary proceffes, both on a large and fmall fcale, Count Rumford's Philofophical Effays may be confulted with much advantage.

To be read after Line 18, *Page* 75.—The price of brick-burning in Nor-

folk is at this time from a guinea to twenty-five ſhillings per thouſand, the brick-burner finding fuel. Perhaps it is as well for the proprietor to provide fuel for himſelf; as, when provided by the man who takes the job, there is great danger that the bricks will be inſufficiently burnt; which is a fraud that cannot be diſcovered till it is too late to apply a remedy.

To be read at the End of Section III, Page 97.—There is another mode of conſtructing cottages that may be had recourſe to with economy and advantage in particular ſituations and circumſtances; this is that of building in what is termed *Pisé,* or ſimply by compreſſing well-wrought earth in moulds or caſes contrived for the purpoſe. It is a method that has been long practiſed in the vicinity of Lyons, in France, with great benefit, and has been attempted in this country with equal ſucceſs. It is particularly recommended by the cheapneſs of the materials that are made uſe of; the facility with which they can be procured in almoſt every ſituation; and the vaſt ſaving in time, carriage, and labour, that attends it; and it is ſaid to afford buildings that are equally neat and durable.

The manner of preparing the materials, and performing the work, with repreſentations of the different implements that are neceſſary to be employed, have been deſcribed, with much accuracy and correctneſs, from the publication of M. Cointeraux, by Henry Holland, Eſq. and inſerted in an Appendix to the Firſt Volume of Communications to the Board of Agriculture, which may be conſulted on the ſubject.

To be read after Line 33, *Page* 103.—It has been ſuggeſted that, in making incloſures, ſomething more ſubſtantial ſhould be given to the poor cottager in exchange for his benefits, whether they be conſidered real or imaginary, which he derives from his common, than the hope of participating with the whole in the general advantage which may be produced. Various clauſes have been provided in different acts of incloſures in this intention. In ſome, much diſpute and inconvenience has been avoided by inſerting clauſes for increaſing the allotments of thoſe owners and proprietors whoſe property may be above the annual value of five pounds, and under ten, ſo as not to exceed the proportions allotted to any other proprietors whoſe property may amount to the annual value of ten pounds. The ſpirit of which ſeems to be: "FIRST, that every proprietor whoſe property is above the annual value of five pounds, and under the annual value of ten, have an extra allotment; and SECONDLY, that the value in this extra allotment ſhall, as nearly as poſſible, be inverſely proportionate to the property to which it is attached; the commiſſioners conſequently taking care that in no inſtance the allot-

ment to the ſmaller property ſhall exceed in value the allotment to the larger." And in reſpect to proprietors whoſe property is under the annual value of five pounds, by allowing them double proportions on a certain part not to be incloſed; or by ſuffering them to have allotments in ſimilar proportions, according to their properties, to thoſe whoſe property was above five pounds.

With the view of beneſiting the ſtill more poor tenants, or renters of cottages, it has been ſuggeſted that by the providing of a clauſe for the purpoſe of allotting a portion of land for the convenience of building a number of ſolid, convenient, and airy cottages, to be held in truſt for the pariſh, many advantages might have been gained*.

To be read after Line 6, *Page* 123.—The white-thorn ſhould, on no conſideration, be *leſs* than four years old when it is planted; if younger, it is unable to encounter the drought of the firſt ſummer. An intermixture of holly in white-thorn fences is at once ornamental and uſeful: the young plants ſhould be carefully weeded and moulded up every ſpring, for the firſt three or four years. They ſhould alſo be cut down the third or the fourth year, within four inches of the bank, in order that they may throw out lateral ſhoots, and thus become thick at the bottom. Too much care can ſcarcely be beſtowed in cheriſhing young fences, in preſerving them againſt the nibbling of ſtock, againſt the ſeverity of drought, and the double injury which weeds commit, by choking them with their own luxuriant growth, and by robbing them of their neceſſary nouriſhment.

To be read after Line 20, *Page* 145.—It has been lately well obſerved, in an able Eſſay on the Conſtruction, Hanging, and Faſtening of Gates, that, when ſuſpended by hinges, a gate is a lever of the ſecond kind, in which the weight is placed between the power and the fulcrum; as it is evident that the hand applied to the head of the gate is the *acting power*, the gate itſelf the weight to be raiſed or moved, and the hinges the fulcrum or centre of motion. "When the hooks or pivots upon which a gate is hung are preciſely perpendicular to each other, the gate will be at reſt wherever it may be placed, and the ſame power which is required to move a gate thus ſuſpended through any given arc of the circle, will be exactly ſufficient to bring it back to its former poſition;" a proof of which is ſeen in a common door to a room with plain hinges. "But the ſmalleſt variation of the hooks from their perpendicular line, will attach to a gate, ſo ſuſpended, one determinate line of reſt; and from any part of the circle which the gate may be made to deſcribe, it muſt have a conſtant tendency to fall to that line of reſt. The line of reſt for a gate will always

* Monthly Magazine, Vol. VII. p. 353.

be where it approaches neareſt to the ground; and from thence being moved half a circle to the right or left, it will there attain its greateſt elevation, and ſupport itſelf, or, with a very ſlight aſſiſtance, may be ſupported in equilibrio. When a gate is in its line of reſt, or in its oppoſite line of equilibrium, the two hooks by which it is ſuſpended, and the centre of the gate's gravitation, will be in the ſame vertical plane with each other; which may be eaſily underſtood by obſerving a common gate, whoſe hinges are put on in any manner, however awkward or perverſe. And when the hooks are in one perpendicular line, it can admit no doubt but that they muſt always be in the ſame vertical plane with the centre of the gate's gravitation, becauſe they will be ſo with any third given point whatſoever. Theſe principles are alſo applicable to a common ſwing gate, which has two or more pivots or hooks at the lower hinge, when the poſition of either one of the lower pivots is conſidered with reſpect to the upper hook*." In explanation of theſe principles, a figure is given which is ſuppoſed "the outline of a gate nine feet two inches long, from the fore part of its head to its upper point of ſuſpenſion, repreſented in the line of reſt, as well as in the oppoſite line of equilibrium; ſhowing the velocity with which the gate is made to fall, from an elevation of ſix inches gained at the head in attaining its line of equilibrium, eſtimated from the line of reſt by means of the poſition of the two hooks, and the proportionate extra length of the lower thimble†." And it is contended that "the line of faſtening ſhould be 22° 30′, or 1-ſixteenth part of a circle, ſhort of or within the line of reſt, and conſequently the correſponding line of equilibrium will alſo be 22° 30′ ſhort of the greateſt extent of the gate's opening‡." But in order "to prevent the gate being left unſhut, it is adviſed that a ſhort poſt ſhould be placed at about half the diſtance between the road to be paſſed and the fence adjoining the hanging poſt, that is 22° 30′ within the line of equilibrium; ſo that the gate ſhould not open from its line of faſtening more than about 135°, which will anſwer every purpoſe; and the hinges muſt be ſo adjuſted that the gate ſhall be perfectly upright at its line of faſtening§." It is ſtated that a gate, ſuſpended in this manner, cannot be left open, (excepting in high winds) but will ſhut of itſelf, though not with an uniformly accelerated motion, as might be ſuppoſed; its velocity being rather increaſed as it paſſes the middle part of its ſemicircular courſe, and retarded again as it approaches its line of reſt, coinciding with the proportionate riſe of the head, allowing only for ſuch acceleration as muſt be acquired while the gate, in falling with a continued motion, recedes more and more from the line of equilibrium. As the *verſed ſine* of the angle formed by the gate with its line of reſt, is to the length of the gate 110 inches, which is the made radius, ſo will be the cor-

* Parker's Eſſay on Gates. † Ibid. ‡ Ibid. § Ibid.

refponding rife of the head of the gate to $3\frac{7}{16}$th inches, or half the whole rife of the gate's head, at any given angle within the quadrant: and the rife in the head afterwards will be, as the *co-fine* of any given angle formed by the gate with its line of equilibrium in defcribing the complement of that angle, is to the length of the gate, or radius, fo will be the correfponding rife of the head of the gate to the remaining $3\frac{7}{16}$ inches, which *co-fine* of the angle formed by the gate, with the line of equilibrium, is equal to the fine of the complementary angle, or angle of the gate's progrefs, from a radius at right angles to, or equi-diftant from, the lines of reft and equilibrium, in performing its fupplementary courfe. Thus it appears, that though the rife of the gate at the head in the firft 90°, or half of its femicircular courfe, be $3\frac{7}{16}$ inches, yet in the firft and laft 22° 30′ of its courfe, it will rife only 1-fourth of an inch, or exactly $\frac{6}{24}$ths and $\frac{69}{116}$ths of a 24th in each refpectively; and rejecting the greater fractions, the rife of the gate's head, and correfponding velocity of the gate's fall in equal eighth parts of its femicircular courfe, is nearly in proportion to the numbers 6, 16, 26, 32, and then inverfely 32, 26, 16 & 6.*

And in further illuftration of the above principles, a "reprefentation is given of the horizontal fection of two hooks for a right-handed gate, opening one way, brought into one plane of obfervation; the upper hook, the lower hook, the line of faftening, the line of reft, and the line of equilibrium. The diameter of the hooks $\frac{13}{16}$ths of an inch, which is the proper fize for a common gate. The horizontal diftance of the lines falling from the two hooks being $\frac{2}{4}$ or $\frac{15}{21}$ inch, is the meafure adapted to hinges which are forty inches afunder. In adjufting the hinges, it is neceffary that the upper thimble fhould incline $\frac{1}{4}$ inch from its centre towards the hanging poft, and that the lower thimble fhould be ferewed into the heel of the gate $\frac{1}{4}$ inch out of the ftraight line, inclining in the oppofite direction, that is, from inftead of towards the hanging poft, both thimbles together making a variation of the $\frac{6}{12}$ inch; and to correfpond with this variation, the upper hook fhould meafure, from the centre of the pin to the fhouldering, about half the thicknefs of the heel of the gate, as the $\frac{1}{6}$ inch inclination of the upper thimble will allow fufficiently for the gate hanging clear of the poft. The lower hook muft be $\frac{6}{12}$ inch longer than the upper hook, and muft be driven into the gate-poft $1\frac{1}{6}$ inch out of the perpendicular line of the perforated parts of the gate-poft, in which the hooks are to be received, as the lower thimble muft alfo exceed the upper thimble in length $1\frac{2}{4}$ inch, fuppofing the gate to be a right-angled parallelogram, or at leaft the rail and heel to be at right angles with each other; elfe the lower thimbles muft be extended by a wafher to make up the deficiency, which, however, will not at all

* Parker's Effay on Gates.

interfere with the velocity of the gate's fall, because the hooks are the centre of motion upon which all adjuftment, as to the gate's fall, depends, the places of the thimbles influencing only the upright pofition of the gate when faftened. The numbers of $\frac{6}{12}$ rather furpafs the precife meafure of their refpective fides of the triangle, but are nearer to the truth in calculation than any workman could attain in applying thefe directions; for in neither cafe do they exceed their true meafure fo much as $\frac{1}{24}$ of an inch, and therefore in the one the clear fum of $\frac{1}{2}$ inch is affumed for general purpofes; and fhould the hinges be lefs than 40 inches afunder, $\frac{1}{2}$ inch will be rather too much; or were they to be more than 40 inches diftant from each other, $\frac{1}{2}$ inch, on the contrary, would be rather too little for the juft proportion. It is certain that a fmall fpace muft be loft in hanging a gate, though the hooks and thimbles be made with great exactnefs; for the weight of the gate will draw the upper thimble to bear upon the hind part of the upper hook, and will prefs the lower thimble againft the fore part of the lower hook; this muft be trifling when the hinges are well fitted, and no allowance is made for it, becaufe the lower thimble gains as much upon the upper one by their being placed $\frac{1}{2}$ inch, that is $\frac{1}{4}$ inch each, out of the plane of the gate's extenfion, as appears by the difference of the fides of the triangle, numbered $\frac{114}{12}$ and $\frac{15}{12}$ equal $\frac{1}{12}$ inch by the meafure $\frac{15}{12}$, which is affumed, but really about $\frac{1}{24}$ inch more, as ftated above, or on the whole equal to $\frac{1}{8}$ inch, which is a good general equivalent for the lofs in hanging a gate, and will ufually be fufficient to preferve the upright pofition of the gate when faftened, without having recourfe to a wafher at the lower thimble*." It is remarked that the "velocity as above given to the gate's fall will be amply fufficient without any care of oiling the hinges; but the effect of wind cannot be counteracted in gates by any good conftruction of the hinges; for were a velocity given to a gate's fall equal to the refiftance of fo powerful an agent, the gate would foon want repair, from the conftant violence of its fhutting, and be fo much the heavier in the hands of a horfeman: befides, when a ftrong wind blew in the fame direction as that of the gate's fall, no man on horfeback would be able to withftand its force; and well conftructed gates are moft liable to be acted upon by wind, from their wide extent of furface. But if paffengers are fo carelefs as to leave gates open under fuch circumftances, there will be one fatisfaction remaining; that is, as foon as the wind ceafes, the hinges muft refume their property, and the gates faften of themfelves†.'

Various directions are given, by which the new pofition of the hooks may be found when the hinges of gates are more or lefs than forty inches afunder. In proof of the accuracy of which, "fuppofe a gate to be 110 inches long, and that it is in-

* Parker's Effay. † Ibid.

tended to rise at the head 6⅞ inches in its semicircular course, from the line of rest to the line of equilibrium; then, as the length of the gate is to the distance between the two hinges, so will be 6⅞ inches to double the horizontal distance of two perpendicular lines, one falling from each of the hooks." Or "take any other distance of the hinges from each other, and the required extra length of the lower thimble may be found by placing the numbers 110 and 6⅞ as the first and second terms of a rule of three proportion, and the new distance of the hinges must be the third term; the answer, divided by two, will be the sought-for horizontal distance of the two perpendicular lines falling from the hooks (adding the loss in hanging the gate); the answer for the one is the measure for the other*." It is supposed that "these general rules will find a tolerably accurate measure in all cases; for where a gate or wicket is short and light, the friction of the hinges will be less in two respects, both by the diminished pressure on the hooks from the gate's lightness, and the reduced diameter of the pivots, which will supply what is wanting in the weight or momentum of the gate. On the other hand, when the gate is long and heavy, its increased weight or momentum, and its length as a lever, will be opposed to the additional friction of the hinges." And "in cases where old hinges are badly made, with large hooks or deep thimbles, that difficulty is to be met by taking the proportion for the distance of the two hinges from each other at five or ten inches more than it really may be, with reference to the given table, or by adding something to the usual horizontal distance of the lines falling from the hooks. But when the thimbles are of a long cylindrical form they are extremely apt to bind upon the hooks, and will sometimes put a dead stop to the gate's motion. With such thimbles the attempt of adding to the velocity of a gate's fall may only increase the binding or friction; and the remedy for this defect, therefore, is to make the hooks much smaller than the thimbles: in new thimbles, no form but that of annular, or ring-like, should be admitted." By "the lower thimble being furnished with a screw of equal diameter throughout its length, its extra length may be regulated to so great a nicety as half a turn of the screw, and may either be let into the heel beyond the shouldering, or lengthened out by a washer as circumstances require, in adapting it either for hinges, which are less than forty inches asunder, or the contrary, without the help of a blacksmith or any fresh forging, which is always troublesome and expensive. And if a gate sinks at the head, without any fault in the hanging-post or hooks, the lower thimble may be lengthened out to bring the gate upright, and the hooks remain unaltered†."

* Parker's Essay on Gates. † Ibid.

Gate-Posts.—These should "be of a sufficient length and strength; and being fixed about eight feet nine inches asunder will be adapted for a gate nine feet long, or nine feet two inches including the thimbles: the thimbles being attached to the gate in the manner above directed, let the gate be supported where it is to hang and fasten, and then drive in the upper hook at a convenient distance from the edge of the hanging-post, so that the upper hinge shall not be in the way of any carriage passing the road, but at the same time so near to the edge of the post as to lose no more room for the road than is unavoidable, by the head and heel of the gate extending a little upon the two posts. It is not necessary to the gate that it should lap against the hanging-post at all; but since the head ought to meet the falling-post, at least with half its own substance, or from that to two inches, the hanging-post should be nearly as much covered by the heel for the sake of uniformity. When the upper hinge is fitted, the gate ought to be supported upright, for ascertaining the place of the lower hook; and if the thimbles are properly put on, the position of the lower hook cannot be mistaken. Both hinges being fitted, it remains to be found whether the hooks are in their exact places; for this purpose take two plumbed lines, with fine threads and heavy even-sided plumbs; if the hooks are well finished, the observation respecting their centres may be taken by fastening the plumbed lines round the hooks, and letting them fall from the outsides of similar parts of the hooks; forty inches being the given distance of the hinges, the horizontal distance of the two lines falling from the hooks should be $1\frac{1}{4}$ inch, and in a line which forms an angle of $22° 30'$, with the gate's line of fastening: take, therefore, a common two-feet rule, and, having opened the legs to the angle of $22° 30'$, place one side of it against the plumbed lines, which ought to answer to the measure of $1\frac{1}{4}$ inch, while the other leg of the rule should be parallel to the gate's line of fastening; a slight blow or two with a hammer on one or both of the hooks, in the direction necessary, will complete the adjustment; and the gate will be found to shut of itself from any line within 135° from its fastening, and without violence, whether opened to the smallest, the greatest, or any intermediate angle prescribed by the short post, which should be placed to meet the middle part of the gate at the angle of about 135° from the line of fastening*." And "it might be prudent, before the short post were put down, to ascertain at what line the gate will stand open, or be poised by the friction of its hinges towards the line of equilibrium, which will discover how near the workmen may have adjusted the line of fastening to $22° 30'$ short of the natural line of rest;

* Parker's Essay on Gates.

and if the gate is found to fall properly, the short post may be put up accordingly, though the method described may not have been minutely pursued, taking care that the short post be sufficiently within the line of equilibrium, and that the gate set off from the short post with a velocity equal to overcome any increased friction by rust on the hinges, for oil should not be used at all, as its occasional aid is not to be depended on*."

It is observed that "indifferent gate-posts are liable to get out of their upright position; the constant weight of the gate must have a tendency to pull the hanging-post inwards; the fall of the gate may make the falling-post recede from the direction of the frequent blows it receives, and heavy carriage-wheels passing near the posts, will occasion them to open outwards; and the natural or artificial slopes of the ground adjoining gate-posts often affect their upright position, and decline them from the higher ground," and many other causes produce similar effects, to obviate which many contrivances have been recommended; such as "mortising the pair of gate-posts together by cross pieces of timber under the road; but the most effectual preventive of the evil appears to be that of letting down the posts very deep into the ground, which will supersede the expense of cross timbers; and in gaining a firm hold at their bases, they will be the better secured both from natural and accidental displacement†." Gate-posts for common gates should be from eight to eight feet and a half in length.

Care is also "to be taken in hanging a gate, to choose the best side for it to open; in doing which there are two circumstances to be considered; the principal one is, that there may be plenty of room for a servant on horseback to hold the gate while a carriage passes, and the other is, to avoid its opening against any cross road or path: Add to which some attention is due to the trespass of cattle from a common road, or otherwise; and it is thought more secure for a gate to open against that side from which the trespass may be most apprehended. In some cases it is advisable to furnish a hanging-post with a pair of hooks on both sides of it, so that the gate can be shifted as occasion may make it convenient‡."

A key-hole and cotter may be put in the lower hook "to secure the gate from being taken off the hinges for idle purposes; or a stud rivetted to one side of either of the hooks, with a little notch cut in the strongest part of the adjoining thimble, is a simple and good contrivance, whereby a gate is prevented from being taken off the hinges when shut, but is easily taken off at some one part of its course when required, where the stud comes opposite to the notch, and admits the thimble to pass over the studded hook." And it is not uncommon to see one hook

* Parker's Essay on Gates. † Ibid. ‡ Ibid.

driven into the poſt with its point upwards in the common way, and the point of the other hook in the contrary direction, which is an effectual mode of keeping the gate on its hinges; but it has the inconvenience of not permitting the gate to be removed without drawing one of the hooks.

The ſame principles are applied in the hanging of gates on the contrary ſides, and likewiſe to thoſe of ſwing-gates; full explanations of which may be ſeen in the very uſeful Eſſay referred to, as well as the methods of ſawing timber for gates and gate-poſts.

The methods of hanging and faſtening, as well as the inconveniencies of ſwing-gates, are alſo explained with great ingenuity and practical accuracy; but they will be beſt underſtood by peruſing the Eſſay, as they cannot be fully comprehended without the plates.

Mr. Parker has likewiſe found, that caſt-iron may be applied with ſuperior advantage to the purpoſe of hanging and faſtening gates, the hooks being attached to the poſts by means of ſcrews, inſtead of being driven in as in the uſual mode. By this means it is ſuppoſed that a ſaving of at leaſt fifty per cent may be made. Complete ſets of which are furniſhed by Meſſrs. Deermans, Francis and Company, Eagle Foundry, Birmingham.

To be read after Line 4, *Page* 152.—In the above reſpect it appears that roads formed on the model of a gently-inclined plane have an obvious advantage; for the very ruts which the wheels make ſerve as channels to conduct the water down the deſcent; at the loweſt point of which a tranſverſe groove ſhould be kept open to convey it into the ditches on either ſide. So extremely gentle is the *neceſſary* deſcent, that grooves at the diſtance of one hundred and fifty yards will be found in moſt caſes ſufficient. The water has thus ſeventy-five yards to run, and the elevation need not be above eighteen inches, or two feet. It is commonly to be obſerved, that the convexity of a road is inverſely proportioned to its narrowneſs. Turnpike roads of the full ſtatute width, unleſs unuſually ſhadowed by trees, receive ſo much ſun and air, that they are kept tolerably dry without much convexity of their ſurface. Narrow roads and lanes are only to be kept dry by artificial means, and ſometimes the convexity is ſo extremely great, as to render the paſſing of two loaded carriages extremely dangerous. Perhaps the gentle convex ſhape is preferable for turnpikes, but the ſhape of the longitudinal-inclined plane has many advantages in narrow lanes, &c.

To be read after Line 6, *Page* 158.—The caſes where it would be neceſſary to carry off the water every ten or fifteen yards muſt be extremely rare; perhaps there are

few fuch cafes. It has been obferved, that " a carriage might almoft as well be floating on a billow at fea, as toffing up and down on an inclined plane every ten or fifteen yards! When a road is conftructed on the principle of the plane, there fhould be no floping of the fides; otherwife the water is impelled by two forces at right angles with each other, and confequently tends in a diagonal line.

To be read at the End of Section V.——*Embankments.*—In many fituations extenfive tracts of land may be gained by the judicious conftruction of embankments. In improvements of this fort, the proper forming of the *banks* conftitutes the principal difficulty and expenfe of the undertakings. The particular circumftances of the cafe muft chiefly direct the operator in regard to the fituation, fize, and manner of conftruction, as well as the nature of the materials which are to be employed. In general, however, the fituation of fuch banks fhould be fuch as that their bafes or foundations may not be unneceffarily expofed to the direct action of waves or currents. Where the quantity of water is in fome meafure limited, as in the cafe of land floods in particular inftances, the greater the fpace it has left to extend itfelf in, the lefs height and ftrength will be requifite in the bank, and the force of the current be leffened in the fame proportion. But where the courfes are liable to be filled up by depofitions, it fhould be recollected that the more the water is confined the ftronger the current will be, and the lefs the danger of their filling up.

In regard to the line of an embankment it fhould always be *even*, and as free from *irregularities* as poffible, in order to occafion the leaft poffible *refiftance* to the currents of whatever kinds.

In forming the bank, the height and ftrength fhould conftantly be made in proportion to the depth and weight of water that it may have to refift, always having the inner face made to incline towards it, for the purpofe of fupport in the way of a buttrefs. The out-face muft be formed in a floping direction, fo as to approach a degree of flatnefs, in order to obviate *refiftance*, and leffen the *preffure* or *weight* of the water. On this being properly executed its firmnefs and durability greatly depend. In difficult cafes, it is advifed that the outer furface fhould form an angle to a perpendicular line of from forty-five to fixty degrees, according to the force to be oppofed and the nature of the materials employed*.

In refpect to the materials, where the foundation is good, firm, and folid, and the bank can be conftructed at a fuitable time, without much interruption from the water, the natural earth of the ground may anfwer perfectly for the body of the

* Marfhall on the Landed Property of England.

bank as well as the inner furface; and where the preffure of ftagnant or almoft ftill water is merely to be refifted, the outer flope may be formed of the fame. But in cafes where the force of either waves or currents operate directly upon the banks, the outer flopes fhould be well fecured againft it, with the beft materials that can be conveniently provided, and the bafes or foundations be properly fecured from being undermined; piles, timber, and mafonry being had recourfe to where the foundations are not fufficiently firm and folid. It is of the utmoft importance in thefe cafes to guard againft accidents.

Befides the conftruction of the banks, attention is alfo neceffary to the forming of the difcharging channels on the outfides of the embankments. The pofition of the mouth, or out-fall, fhould conftantly be fuch as that the current of the receiving waters may not warp or fill them up, but tend to clear them out, and keep them free. They fhould likewife be fituated as low as they can be conveniently permitted below the flood-gates of the banks, the better to induce currents, and thereby keep the flood gates and the mouths of the channels the more free and open.

In cafes of open feas or other extended waters without any difcharging channels, but where the waves extend to the foot of the banks, two flood-gates may fometimes be neceffary, one on the external fide, to refift the force of the waves, and prevent their *blowing up* the works on the infide; the other on the inner fide, to fecure the paffage more fully. Thus, when water is admitted by the outer flood-gate being lifted by the waves, its progrefs is effectually ftopped by the inner valve being in a perfect ftate. Where the valves are liable to be choked up, from being fituated below the furface of fand or other fhifting banks through which the water forces its way, and are only capable of being kept clear by conftant trouble and expenfe, the remedy, in difficult cafes of this nature, is that of defending the difcharging flood-gates by *covered* channels carried out into the fea through the line of beach, made fufficiently ftrong to refift the force of the waves, This is however an expenfive method, and fhould of courfe be avoided when poffible*. In all cafes where external valves or gates are required, and liable to be filled up, great care muft be taken to keep them open and free, either by piles, fences, or other contrivances, run out in fuch a manner from the embankments as not to interrupt the difcharging water, the earthy materials collected by it being occafionally removed.

In thefe cafes, common *hinge flood-gates* may be the moft proper, or fuch as fwing outward, and fall into a rabbetted frame. They fhould be always made of feafoned oak timber; being made double, by the different planks croffing each other, in order to prevent their warping. They fhould be fo contrived as to fit pretty tight, with-

* Marfhall on the Landed Property of England.

out being liable to ſtick by ſwelling. This is effected by the edges being made to ſlant or bevel inwards. The frame ſhould likewiſe incline a little inward, but not ſo much as to retard the exit of the contained water. Where rivers or ſtreams paſs through embanked grounds, the ſides may frequently require to be raiſed ſufficiently to prevent their overflowing in times of floods. And where they are too low to be fully drained, it may be neceſſary to form embanked channels or cuts for receiving the water when thrown up by machinery. Theſe embanked channels may be converted to various uſes, ſuch as irrigation, &c. in different caſes *.

Embankments have been divided into three different kinds, as thoſe againſt the ſea, againſt rivers, and againſt lakes, each of which ſhould be formed according to the reſiſtances required. The firſt, however, in general require by far the ſtrongeſt and moſt expenſive works †.

In embanking againſt the encroachments of the ſea, it ſhould firſt "be conſidered what is the greateſt depth of water at the higheſt ſpring tides. About two feet higher than that ſhould be the ſummit of the bank. Some have recommended only one foot higher, but it is beſt to err on the ſafe ſide; for the conſequences attending an overflow, after the whole is completed, may, in one tide, do a great deal more damage than all the expenſe of the additional foot in height. If the embankment be made at firſt even three feet higher than the higheſt riſe of the tide, eſpecially at thoſe places expoſed to the waves or ſwell of the ſea, it will be ſo much the more ſecure, for new works of this kind always ſubſide or ſettle in ſome degree after they are erected. It is a very neceſſary precaution, particularly if the banks are large, to take the levels frequently for ſome time after they are completed, leſt they ſhould ſubſide too much, and thereby occaſion a miſchief which it was imagined had been ſufficiently guarded againſt. If the banks are but low, this precaution is not ſo neceſſary, for the ſettling will always be more or leſs according to their height, and in low banks will be but very little. It is hardly poſſible to give one general rule reſpecting the ſize and dimenſions of ſuch embankments. This muſt be regulated according to circumſtances and ſituation, for which a ſkilful engineer will always make the proper allowances. If the embankment to be made is to exclude the ſea from a low marſhy piece of ground, over which it flows only at ſpring-tides, the operation is eaſy, and may be effected at a ſmall expenſe. If it is intended to reclaim a piece of land that is covered every tide, either in ſome bay or creek, or on the ſides or windings of ſome large river

* Marſhall on the Landed Property of England.

† Beatſon in Communications to the Board of Agriculture, Vol. II.

in which the tide ebbs and flows, the work will be fomewhat more difficult, in proportion to the depth of the water and the rapidity of the current. If it is propofed to exclude the fea from fome expofed fituation, either at the mouth of a river, or in a bay or inlet uncovered every tide, the work will be the moft difficult and moft expenfive of all, in proportion to its expofure to prevailing winds and to the depth of water to be refifted. Each of thefe fituations require a different mode of management. Embanking againft the fea, if at any confiderable diftance within high-water-mark, is not only the moft tedious, but the moft difficult of all; for if the materials are not very good, and the work is not properly performed, the force of the water at every flowing of the tide will foon undo all that has been done, efpecially if the foil is of a fandy nature, as it often is in fuch fituations. If it is a ftrong clay, as is fometimes the cafe in marfhy places, there will be the lefs rifk of its being wafhed away. In fandy fituations it has by fome been recommended to lay bundles of ftraw or reeds well faftened down, or any other impediment, to prevent the foil being carried away by the ebbing tide. Where a fufficient quantity of good ftrong turf cannot be had, then expedients may be tried; but where fuch turf is to be got, as in moft marfhy fituations, and where the embankment required is not to exceed the height of four or five feet, it is beft to finifh the flope with good turf as expeditioufly as poffible as the embankment proceeds; that is, fuppofing a length of thirty, forty, or fifty feet, or yards, of it can be completed in a tide, it is better to finifh that length to its intended height, than to trace out or begin a greater extent than can be finifhed before the tide returns, by which a great deal of the foil might be carried away, and much of the work demolifhed, which is not fo likely to be the cafe when the flope is finifhed. Turf, containing the roots of bent or rufhes, is very good for this purpofe. The firft thing, however, to be done in an embankment of this fort is, to ftake out the intended line of it, marking the breadth at the bafe, alfo the width of the excavation, or trench, to be made in the infide, from which moft of the materials that compofe the bank are to be taken; this trench alfo ferves as a drain to keep dry the grounds within. At different parts of it fhould be trunks, or fluices, to fhut of themfelves againft any external water, and to open, when the tide ebbs, to let out any water from within. Its width muft be proportioned to the quantity of materials required from it for the embankment—eight, ten, or fifteen feet wide, and three or four feet deep, leaving a *berme*, or fpace between the edge of the trench and inner bottom of the embankment. If the foil is ftrong, one foot or eighteen inches will be fufficient for this *berme*; if it is loofe or fandy it will require at leaft three or four feet *."

* Beatfon in Communications to the Board of Agriculture, Vol. II.

The more gradual and easy the external slope is made, the resistance against the sea will of course be the less sudden, and the embankments less liable to injury: this slope must therefore be made according to its exposure to the winds and tides; but nothing can be a greater error than to make it too bold or upright *." See Plate XXXVIII. *Fig.* 1. "The inside slope should also be faced with turf, which may be laid with the green side downwards, as in building any common sod wall. Some expert sodders can finish this kind of work extremely neat, by setting the sod on edge, according to the slope intended to be given, and with proper mallets and beetles ram the earth hard behind, which consolidates the work as it advances, and tends very much to its durability. When the first or lower course is finished, they pare the upper edge of the sods with a sharp knife quite even by laying a rule to them; and then they go on with the second course, which they finish in the same manner, and so proceed till the whole height is completed; which, when finished properly, looks very beautiful and smooth, not a joint between the turfs being seen. If turf is to be used in covering the outside slope, it must all be laid with the grass uppermost, and well beaten down with a flat sod beetle for that purpose; and for their better security it may not be amiss to drive a small stake, of about eighteen inches long or more, through every sod. The sods for this purpose should at first be carefully taken up and traced by a line, all of the same breadth, and their edges cut as even as possible, that they may make the closer joints, which will tend very much to their security till they grow properly together. In laying the different courses of these sods, care should likewise be taken that the joints of the one are covered by the other, in the way that good brick-work is made."

If it be proposed to reclaim a piece of land upon which the sea ebbs and flows every tide to a greater depth than in the foregoing case, as in a creek, or on the side of a large river, a different mode of proceeding, it is observed, must be adopted according to the soil and to the materials intended to be used. "If there are plenty of stones to be easily had, a bulwark may be formed of these, with a mixture of clay, either by land-carriage, or (which in some cases is preferable) by carrying them in flat-bottomed boats, or punts, and throwing them overboard till a bank is accumulated. If stones cannot so easily be had, a quantity of clay, or other materials fit for the purpose, thrown in in the same manner, may answer equally well. It is supposed that most of the embankments in Holland were done in this manner, by carrying the clay dug out of the canals in boats, and throwing it into the water. In either case it is necessary to fix up strong poles before the work is begun, as guides for laying down the materials. Sluices are also requisite at certain places to let out

* Beatson in Communication to the Board of Agriculture, Vol. II.

the back water when the tide ebbs; but the pofition and conftruction of thefe depend fo much on local circumftances, that the engineer who conducts the work ought to be the beft judge where and how to form them. A great deal depends on a fkilful engineer in works of this kind, who will contrive many ways to facilitate the work, and to overcome all difficulties in the execution of it." *

The following " fpecies of fea-embankment is perhaps the moft important of any; for there are few eftuaries, or mouths of rivers, where large and valuable tracts of land may not be gained by fuch means. The fhoals, or flats formed at the entrance of fuch rivers, are often compofed of the richeft manures or moft fertilifing particles, brought down by the ftream from the towns above, or from the adjacent country through which the river flows. Thefe fhoals may therefore, by proper management, be in general very eafily converted into the moft fertile plains. Where fuch a fituation happens, the firft object is to collect the whole river into one ftream, and to prevent its overfpreading a wider extent than juft fufficient for its difcharge; or, perhaps, it may be better to alter the courfe of the river altogether, and to make it difcharge itfelf at fome other place. The principle upon which that idea is founded, is this:—It has been obferved, and proved by experience, that if the courfe of a river or ftream be altered in fuch a manner as to make it difcharge itfelf into the fea at a different place than it did before, the former place will in a few years, by the conftant accumulation of fand or mud brought in every tide, be fo choked up or raifed above its former level, as to form of itfelf, in procefs of time, a bank that, with a very little affiftance, will quite exclude the fea: for as the current of the river before carried away all that fediment which the motion of the waves naturally ftirred up, the current being removed, all or moft of the muddinefs will not only be carried further up the old channel of the river, but a great part of it be depofited there as the tide recedes. It has even been obferved, that in fpring-tides and particular winds this fediment is depofited in greater quantities than at other times; and Mr. Beatfon has been informed that on making a perpendicular cut in the land fo gained, the different ftrata or layers were fo diftinct, that thofe made at fpring-tides could eafily be diftinguifhed from the reft. This is a very curious fact, and well worth the attention of all who have lands fituated at the mouths of rivers, as there may, in many fuch places, be confiderable tracts gained in this manner at a very fmall expenfe. Although this fact may be proved by experience in fome places, neverthelefs he fhould imagine the effect would not be the fame in all fituations. Where there is a great extent of flat or muddy fhores, the motion of the waves

* Beatfon in Communications to the Board of Agriculture, Vol. II.

will no doubt ſtir up the mud or ſand, and carry great quantities of them along with the current on the flowing of the tide; and when the tide ebbs, although ſome of the lighter particles will be carried away again, yet it is natural to ſuppoſe the heavier ones will be left behind. If the ſhores are bold and rocky, except juſt near the entrance of the river, there will be the leſs of this mud; but, indeed, on ſuch ſhores there can be little or no occaſion for embanking, unleſs, perhaps, in ſome creeks, narrow at the entrance and ſpreading wide above. From ſuch creeks, if the ſea were excluded, a great deal of land might probably be gained*."

It is remarked, that "embankments againſt rivers may be divided into two ſorts; namely, thoſe for preventing their encroaching on the adjacent lands, and for protecting thoſe lands and the neighbouring level country from being overflown when the water riſes above its ordinary level. It may be obſerved, that where the courſe of a river is a ſtraight line, or nearly ſo, it hardly ever makes any encroachment upon its banks, unleſs, perhaps, in very large rivers, when they riſe above their common level either owing to an increaſe in the waters, or to their being in ſome degree affected by the tides. In either caſe the waves occaſioned by a ſtrong wind, where the river is wide, will moulder away the banks on that ſide upon which it blows, unleſs prevented in proper time. This may be done either by ſecuring the bank properly with ſtones, or by driving a row of long piles pretty cloſe together, at a little diſtance from the ſhore; the piles being of ſuch a length, and ſo driven, that their tops may be always above the higheſt riſe of the water. It is ſurpriſing the effect that piles driven in this manner have in reſiſting the power of waves. Some years ago, when on duty as an engineer at a fort near Portſmouth, built on a point of land much expoſed to the ſea, the waves made ſuch havock that the walls on that ſide were conſtantly giving way although built in the moſt ſubſtantial manner, and having bulwarks of large heavy ſtone beſides to protect the foundation: however, all would not do; thoſe bulwarks were ſoon knocked to pieces, and ſeveral times the wall itſelf. At length it was propoſed to drive a number of piles at about forty to fifty yards from the fort. Thoſe piles were twelve or fifteen inches in diameter, and driven about one diameter from each other, nearly in a ſtraight line, parallel to the wall where the waves did ſo much damage. They were driven into the ground with a pile engine till perfectly firm, perhaps eight or nine feet deep, and about two feet of the top of them left above the level of high water mark. After this was done the walls received no further injury, the ſpace between the piles and the fort being always perfectly ſmooth however tempeſtuous the waves

* Beatſon in Communications to the Board of Agriculture, Vol. II.

might be without. The ſame ſimple method might ſometimes, perhaps, protect the banks of large rivers expoſed to the waves when other methods fail*." But " the moſt common cauſe of rivers' encroaching on their banks is, the reſiſtance occaſioned by a ſudden bend. In flat countries, apt ſometimes to be overflown, where there are any ſuch bends or windings in the rivers, it would be of great advantage to ſtraighten the courſe as much as poſſible; for as every impediment or obſtruction will naturally cauſe the water to riſe higher than it otherwiſe would do, and as ſuch bends have that effect, conſequently in the time of a flood the waters will overflow a greater extent of country, and to a greater depth, than if the river had a free and uninterrupted courſe ſtraight forward. If the windings of the river cannot be altered, and that encroachments are making on ſome part of the banks, it muſt firſt be conſidered whether the force of the water can be diverted to another place where no injury can be done†." See Plate XXXVIII. *Fig.* 2. On the river Nith, in Dumfrieſhire, it is obſerved, " a good deal has been done in this way by Mr. Millar, of Dalſwinton. See Plate XXXVIII. *Fig.* 3. As the river was encroaching moſt rapidly, and ſeemed inclined to take a new courſe, which would have deſtroyed ſome very fine land, and done a great deal of miſchief in that part of the country—To prevent this, Mr. Millar made a large cut about four hundred yards in length, and threw in a great quantity of ſtones quite acroſs the river to direct its courſe in a ſtraight line. This had in a great meaſure the deſired effect, by totally preventing its progreſs; but now it began to encroach on its banks at another part. He at firſt endeavoured to prevent this by driving in, at a conſiderable expenſe, a number of piles at a little diſtance from the bank, and wattled them with willows, branches, &c. thinking thereby to protect the bank. The piles were drove in with heavy mallets, apparently firm into the ground; they continued ſo for ſome months till a heavy fall of rain came on, which ſwelled the river, undermined the piles, and carried them all away. But it is in vain to think of piles doing any good in ſuch a ſituation unleſs firmly driven in by a pile engine, for it is not poſſible to drive them in properly with mallets. This muſt have been the cauſe of their giving way ſo very ſoon. The piles not ſucceeding, he was reſolved to try another plan. Several of his adjacent fields being covered with an immenſe quantity of ſtones, he ordered them to be gathered and thrown into the river, ſo as to form a jutty a little way above the injured bank. Being obliged to go from home about that time, and leave the execution of the work to ſome country people, they carried out this jutty too much at right angles to the ſtream; it had

* Beatſon in Communications to the Board of Agriculture, Vol. II. † Ibid.

not therefore the desired effect, but rather made the matter worse than before; for if a jutty is carried out at right angles, the current will be forced to the opposite side of the river, and thence it will rebound more violently than it did before. But if a jutty is placed obliquely, it will force the current gradually on the other side, in which position one jutty may do more good than several placed improperly at right angles. He was therefore under the necessity of making other jutties in this way, and has now the satisfaction to find that they answer the purpose intended. Those he made laterally formed a sort of convex slope, the convexity being parallel to the current. Strong planks were also firmly set on edge among the stones, their ends pointing towards the river; so that if ever any current came so rapid as to move any of the stones, it must move them all in a body the whole length of the plank. Perhaps this precaution was unnecessary; for although stones are thrown into a river loose in this manner, the slush, sand, &c., that come down the river, will soon fill up all the cavities, and render it as firm and solid as a regular built wall *.

"The next sort of embankments against rivers are, it is observed, those to prevent them overflowing their banks, and inundating large tracts of country. This may be considered as the simplest and easiest of all sorts of embanking if judiciously executed. It is therefore the more inexcusable to see in some places extensive tracts of the richest meadows completely overflown by every flood. Few ordinary-sized rivers rise more, even in the greatest floods, than five or six feet above their common level, unless when they meet with some considerable interruption or confinement in their course. But if interrupted or confined, they will rise perhaps twenty feet or more. If, for example, a given quantity of water is six feet deep when running over a space twenty feet wide, it is clear if that space were made only ten feet wide the water would rise to twelve feet; and if it were made forty feet wide, the same quantity of water would rise only to the height of three feet. It is therefore of great consequence, in preventing inundations, to give the river as much width as possible, by widening every narrow place. All kinds of obstructions should also be removed, whether occasioned by windings, shoals, stones, trees, bushes, or any thing else. In some cases this may even preclude the necessity of embanking; but where embanking is necessary, let the banks by all means be at a sufficient distance from each other to contain with ease between them the largest contents of the river in great floods. The distance and height of the banks may easily be ascertained by measuring a section of the river when at its highest, or when the flood-mark is visible. Where a sufficient distance is allowed between the embankments, their height need not ex-

* Beatson in Communications to the Board of Agriculture, Vol. II.

ceed from four to fix feet. If irremovable obftacles are in the way which caufe the river to rife higher, the banks muft be higher in proportion. In either cafe, however, the flope of thefe kinds of banks on each fide may be equal to its perpendicular height, and the breadth on the top about one-third of that height; which, fuppofing the bank fix feet high, the bafe would be fourteen feet, and the breadth of the top two feet. See Plate XXXVIII. *Fig.* 5. The materials for making thefe banks fhould be taken as much as poffible from the fides of the river, which will have the double effect of widening the river and forming the embankments; and there fhould be a trench on the infide (from which materials may alfo be got), with fome fluices, as formerly directed, to drain off any water from within; alfo fluices to let in water from the river, if required, which would very much fertilife the meadows if properly laid out for that purpofe*."

Farms fituated on the borders of rivers are often liable to injury and inconvenience from them in different ways; as from part of the foil being carried away in times of flood, from the rivers overflowing their banks, and from the rivers in times of flood flowing back into the channels of the rivulets and ftreams that conduct the water from the more elevated and diftant grounds to the rivers, whereby thefe rivulets and ftreams are made alfo to overflow their banks. The danger of the foil being carried away in time of floods is increafed or decreafed according to circumftances; as the form of the banks, the nature of the foil, the rapidity of the river, and the quantity of the water that lodges on the margins of the banks or falls over them into the river. Where the banks of a river are perpendicular, if the foil be of a fandy or rich mouldering nature, the danger of part of them being carried away by floods is greater than where they flope gently from the furface of the field to the bed of the river, which when they do not they fhould be made fo. But if the foil and fubfoil be an entire mafs of clay or ftrong loam, and the current of the river do not prefs more upon one part than another, a fubftantial improvement may be effected by floping the bank fo that the declivity may be one foot in three or four from the furface of the field to the bed of the river. And where gravel mixed with fmall ftones can be conveniently procured, fpreading thefe materials on the floping bank, to the depth of eight or ten inches beyond the flowings of the river, may prove a good fecurity againft further damage; and if the bank be planted thickly with any fort of willow, it will in a fhort time become an impenetrable fence, and the annual cuttings of wood foon be equal to the value of the

* Beatfon in Communications to the Board of Agriculture, Vol. II.

land thus occupied. Where no gravel can be procured, the new ſloped bank ſhould be immediately covered with well ſwarded turf, which ſhould be beaten down as hard as poſſible, either by the back of the ſpade or with wooden mallets. If this be done in the beginning of ſummer, and willows be planted the following autumn, the improvement may be effectual and permanent. In order to prevent the effects of a current againſt a particular part of the bank, a fence or bulwark of ſtone in the front of the place may be neceſſary; the beſt way of doing which is, to drop the ſtones in a careleſs manner, but ſo as they may lie cloſe together on the ſloped bank, care being taken to lay them all the way from the bed of the river, till conſiderably beyond where the river flows in common. In level, or nearly level diſtricts, all that is neceſſary is to ſecure full ſcope for the rivers to overflow their uſual bounds without interruption: when that is ſecured by either of the methods before mentioned, floods, unleſs very violent, ſeldom do any material damage to the banks of rivers in ſuch ſituations. It is in many caſes extremely difficult to guard rapid running rivers in ſuch a manner as to prevent part of the banks from being carried away by inundations. Neither ſloping the banks nor ſtrong bulwarks made of ſtone would here be effectual; the method of filling a ſort of large open baſkets, placed along the bottom of the banks, with ſtones, has been found ſucceſsful, and, as theſe baſkets may be made to contain two or three tons of ſtones, it can only be on few occaſions, and in very particular ſituations, that they can be diſplaced or carried away. Much damage is often done to the banks of rivers in level diſtricts, eſpecially if the banks be perpendicular and of a conſiderable height, by allowing the land-floods to fall over them into the rivers. As the water from the furrows approaches the bank it is frequently ſtopped in the furrow of the head-ridge, which becomes for a time a kind of reſervoir; the conſequence of which is, that a conſiderable proportion of the water ſinks and filtrates through the earth, which, being thus ſoftened and ſwelled, is more eaſily undermined and carried off by the river. Sometimes little cuts or openings are made from the furrows acroſs the head-ridge for the purpoſe of conducting the rain-water into the rivers, the conſequences of which are equally bad; as at every one of theſe cuts or openings a little creek is formed, in conſequence of the bank having been more ſoftened, and by that means having become a more eaſy prey to the rivers when in flood. To prevent theſe evils, it is neceſſary, beſides ſloping the banks, to devote a part of the lands adjoining, to the breadth of twenty or thirty yards, either to paſturage, or the growth of trees; and to form a drain at a proper diſtance from, and parallel to, the bank for the purpoſe of collecting and carrying off the

water from the furrows. By this means, and conducting the water from this drain into the rivers by conduits, formed a little above their ordinary levels, much land which is annually loſt would be preſerved*.

Various injuries happen to the farmers in level tracts, where the banks of the rivers are low, and where the courſes are not of ſufficient breadth to contain the water in time of flood. By forming mounds of earth, the ſides of the drains propoſed to be made for carrying off the land-water being well ſloped on the ſides towards the rivers, the rivers would be prevented from doing injury to the adjoining lands; as by theſe mounds being placed at a diſtance from the river, the force of the ſtream would be much leſſened, and the natural boundaries of the rivers greatly enlarged. And where injury is ſuſtained by the rivers during floods flowing back into the channels of the ſtreams that bring the waters from the more elevated grounds, the beſt method is to erect mounds at a diſtance from the banks, and of a ſize proportioned to the quantity of water which, from the cauſe now mentioned, may be ſuppoſed at any time to ſtagnate in theſe channels. This may be done at a very trifling expenſe either in money or land. If the proprietors do not chooſe to ornament the country and improve their eſtates, by planting trees on the borders, the farmers may ſo conſtruct the mounds as that they may become fences to their arable fields, while the portion of land cut off may be devoted to paſturage †.

Where the water coming from the hills or high lands are conſiderable, and the courſes of the rivers extremely ſerpentine, ſo as to produce much injury on the flat lands below by the ſtagnation that is produced, advantage may be derived in other ways, as by ſtraighteningthe courſe of the rivers, and interrupting the water coming from the high lands above them, by cutting proper drains and channels along the face of the declivity as ſhown in Plate XXXVIII. *Fig.* 6. ‡

In embanking againſt lakes, it is obſerved that " as the waters ſubſide greatly in the ſummer ſeaſon, and riſe conſiderably in winter, or when the ſeaſon is wet, advantage may in ſome caſes be taken to confine them within their ſummer limits, or at leaſt to cut off ſome of their branches or creeks. When either of theſe is to be attempted, the principal outlet muſt firſt be examined, and that ſhould be enlarged and widened conſiderably, which, upon the ſame principle as already mentioned reſpecting the widening of rivers, will prevent the water riſing ſo high as formerly. If the levels will not admit of much depth being got, or if the ground is rocky, and would be difficult and expenſive to deepen, let the breadth be increaſed as much as poſſible, and

* Modern Agriculture, Vol. IV. † Ibid.

‡ Farmer's Magazine, Vol. II. p. 119.

every obſtacle cleared away, that the water may run freely into a ſhallow ſtream. If it is required to aſcertain exactly, or to fix the future limits of the water, a ſection of the greateſt quantity running out during a flood ſhould be taken. Suppoſe this ſection, for example, ten feet wide and four feet deep; by making it 40 feet wide, the ſame quantity of water will not riſe above one foot: conſequently, by this means alone, three feet in height will be gained all round the lake, which, in caſe of embanking it, would be a very great object*."

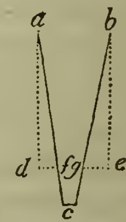
The ſummer ſeaſon is the beſt time to carry on theſe as well as other embankments; but when materials are to be brought from a diſtance, they may be laid down or prepared at other ſeaſons, excepting the turf, which ſhould always be uſed as ſoon as poſſible after it is cut. The manner of conſtructing embankments of this nature is the ſame as in other caſes. The methods employed in making embankments againſt the ſea on the eſtate of Lord Galloway are repreſented in Plate XXXVIII. at figs. 7, 8, and 9. They were formed to the heights of three and a half and five feet, having the breadths of ſix feet and five feet at the baſes, and 20 inches at the tops. They were conſtructed almoſt wholly of turfs or ſods, with only a little well beaten ſtuff in the middle of one of them; and with two ſmall drains, one on each ſide, about two feet in depth, coſt about 3d per yard. In executing all ſorts of embankments, the greateſt care ſhould be taken to make them perfectly firm and water-tight, by conſtantly beating and ramming them well while they are forming.

To be read after Line 22, *Page* 216.—It has been ſuggeſted that the oily particles with which the fleece of ſheep is charged, exſuded without doubt from the animal, though an imperceptible, may probably be a powerful manure; when ſheep lie down, this animal exſudation may be abſorbed by the ſoil. It might be worth inveſtigation, whether this ſecretion be more copious in one breed of ſheep than another; and whether it equally abounds in the fine ſhort fleece of the Norfolk breed as in the coarſer but more ample clothing of the Leiceſter, South Down, &c. To the oilineſs of their fleeces may alſo perhaps be attributed the great injury which ſheep commit on young trees, by rubbing themſelves againſt the bark.

To be read after Line 32, *Page* 290—The ordinary method of forming theſe ſuperficial drains is to excavate channels in the form of a wedge, that is to ſay, with the

* Beatſon in Communications to the Board, &c. Vol. II.

ſmooth ſides narrow at the bottom and diverging towards the ſurface of the earth: thorns and ſtraw are then ſtamped firmly in with the foot, and the drains are covered over with mould. Unleſs the ſoil be very ſtiff and tenacious, the ſides of the drains are very liable to be torn by the force with which the thorns are preſſed in; and the channel, which ought to be preſerved quite open at the bottom, oftentimes half choked by the looſe earth which crumbles in. Inſtead, therefore, of forming the drains in the ordinary ſhape, it is perhaps better to make a ſhoulder for the thorns to reſt on; thus,



ac and *bc* repreſent the ſmooth ſides of an under-drain, as it is uſually formed:—rather than form the ſides thus approaching to each other at the bottom, it is *perhaps* better to cut down perpendicular the two dotted ſides *ad* and *be*, leaving the ſides, and the ſhoulders *df* and *ge* for the thorns to reſt on. Below this ſhoulder the water has an uninterrupted channel for its courſe. At the mouth of the drains, that is, where they diſcharge themſelves into the ditches, it is adviſable to lay a ſmall plank transverſely. Sheep in the ſummer time run into ditches, and without ſome ſuch preſervative as this, they are likely to ſcratch a quantity of mould into them.

The advantages of draining have been exhibited with ſingular effect in the neighbourhood of Eaſt Devon. Mr. Munning informs us, that at Michaelmas, 1795, Mr. Salter of Winburgh entered upon the occupation of more than eight hundred acres of *heavy* land, which had been ſo entirely neglected by his predeceſſor, as to be almoſt altogether what it ought *not* to have been.

Mr. Salter immediately ſaw, that unleſs he could get rid of the ſurface water all his labour muſt be fruitleſs, and his money expended in vain; he therefore began his operations by cutting 342 rods (of 7 yards to the rod) of *river* through the centre of the farm, 7 feet wide and 6 feet deep perpendicularly, in order to obtain an outlet for the water to flow from his other works: he cut 2937 rods of new and old ditches, 6 feet and 5 feet deep perpendicularly; 1116 rods of open drains, of various widths and depths, from 4 to 5 feet wide, and from $3\frac{1}{2}$ to $4\frac{1}{2}$ feet deep perpendicularly; and he cut and filled up 4871 rods of under-draining, of which the leading drains were 36 inches, and the feeding drains to the ſame 30 inches deep perpendicularly. The whole of this work was executed and completed in one year! Mr. Salter has continued to do a great deal every year ſince 1795: between Michaelmas 1800 and Michaelmas 1801 he executed 4423 rods of under-draining of widths and depths as before expreſſed; and he is now going on with the ſpirit and the judgment of an experienced and an underſtanding agriculturiſt. The effect has been, that on the

land which was ſo much impoveriſhed by ſtagnant water, and ſo much inundated by land-ſprings, as not to reproduce the ſeed uſed upon it, his crops have been abundant; and while Mr. Salter reaps the benefit of his judicious exertions, he may very fairly be regarded as a public benefactor. He may almoſt be conſidered as producing a new creation around him, and ſhould be held up, by every friend to agricultural improvement, to the admiration and the imitation of all who have to do with heavy land from which it is neceſſary to remove the ſurface-water*.

To be read after Line 31, *Page* 326.—Straw alone muſt, however, often be inefficacious, as there is no ſoil ſo tenacious as not to be liable to crumble. Froſt penetrates deeper into wet lands than dry ones: evaporation is greater in the former caſe than in the latter, and heat is evolved with more facility. Many of the eſtimates of the expenſes of draining, from the great riſe in the price of labour, are conſiderably lower than the preſent prices.

To be read after Line 2, *Page* 368.—In Norfolk they occaſionally make what is called a *baſtard ſummer-till.* If a piece of land, from which they have mown a crop of clover or any artificial graſs, appears to be not ſufficiently clean for the enſuing wheat-crop, they plough it twice, and, if there is time, thrice before harveſt, uſing freely both the roller (if it is neceſſary) and the harrow. They ſometimes even make a *baſtard* ſummer-till of a pea-ſtubble, for the purpoſe of cleaning it. As ſoon as the peas are off the land, which oftentimes happens four or five days, and ſometimes a week, before the harveſtmen are taken home, they harrow the haulm up and cart it off; plough the land once immediately, and let it lie till harveſt is over; then give it two croſs ploughings, and a fourth preparatory for ſeed, which, however, is oftentimes ploughed in with the laſt earth.

To be read after Line 5, *Page* 541.—The Rev. Dr. Pike has ſtated, upon the conviction of many experiments, that wheat will thrive as well, and produce as full a crop, if ſown in the ſpring, as if it had been committed to the ground the autumn before; and in many ſituations he is of opinion (where it is ſubject to much wet during the winter) the crop will be much better in quality and more abundant in quantity. "I have frequently ſown," ſays he, "in the ſpring both the white and the Kentiſh red wheat, ſometimes as late as the middle of March, and never had a

* Munning on the Culture of Turnips.

crop fail that was ſown at that time: nor have I ever found any conſiderable difference in the times when the autumnal and the ſpring crops ripened."

Dr. Wilkinſon, of Enfield, an intelligent agricultor, recommends the cultivation of ſpring-wheat, as a ſpecies of grain which, although ſown ſo late as the 11th of May, he has found, by experience, to ripen with the autumnal wheat. He obſerves that ſpring-wheat was known to the Romans as a ſpecies diſtinct from the common wheat, and deſcribed as ſuch by Columella, who conceived it very acceptable to the farmer, when, on account of floods, or rains, or other cauſes, he had been prevented from ſowing the autumnal kind. And Mr. Dickſon, in his account of the Agriculture of the Antients, took it for granted that it had never been cultivated in England, and expreſſed a wiſh that the experiment might be made. He conſiders it as well adapted to the wet climate of Scotland, where, owing to heavy rains, the farmers are frequently reſtricted in regard to the quantity of wheat that can be ſown. Common wheat, he ſays, has been ſown in ſpring in Scotland, but has frequently failed. By Linnæus it is termed *Triticum æſtivum*, ſummer or ſpring wheat.

It has four flowers in the calyx, three of which moſtly bear grain: the calyxes ſtand pretty diſtant from each other on both ſides of a flat ſmooth receptacle. The leaves of the calyx are keel-ſhaped, ſmooth, and they terminate with a ſhort ariſta. The glumes of the flowers are ſmooth and bellying, and the outer leaf of the glumes in every calyx is terminated by a long ariſta; but the three inner ones are beardleſs. The grain is rather longer and thinner than the common wheat. It is ſuppoſed to be a native of ſome part of Tartary*.

Mr. Ray alſo, he ſays, claſſes it as a diſtinct ſpecies. It is generally ſuppoſed to have been introduced into this country about the year 1773, under the name of Siberian wheat, Switzerland wheat, or *bled de Mars*. It is however mentioned by Harriſon, an hiſtorian in the time of Elizabeth, though he ſays it was known only to few huſbandmen.

In Doſſie's Memoirs of Agriculture and other Œconomical Arts, Vol. III. a detail, the Doctor obſerves, is given of ſome experiments on the cultivation of this wheat, communicated by ſeveral gentlemen, to the Society of Arts. The obſervations there recorded, he ſays, agree with his own experience. The lateſt ſown, however, was the latter end of April; the produce is ſtated at three and two quarters per acre. The experiments ſeem to agree in deciding, that no advantage was gained by ſowing it early. Wheat ſown in April ripened as early as what had been ſown the beginning of March.

* Bryant's Flora Diætetica.

That it does not tiller like common wheat, but ſhoots up immediately from its firſt appearance above ground. That the grains are ſmaller than common wheat, but increaſe in ſize when ſown on rich land. That it is liable to the ſmut. That it would ſucceed in the fens and low lands, which are ſubject to winter-floods. That it would be worth trying in the mountainous parts of Derbyſhire, Yorkſhire, &c. where little or no wheat is ſown, the ſituation being too cold for wheat ſown in the autumn to ſtand the ſeverity of winter, froſts, and rain, without periſhing. In the firſt volume of the Tranſactions of the Society of Arts, Sir Wm. Fordyce, he remarks, gives an account of an experiment on ſpring or Siberian wheat, in which two buſhels of wheat produced two quarters of grain. It was ſown the beginning of April, after turnips, and was found to prove an excellent nurſe of clover and rye-graſs, ſown at the ſame time. The turnips had been drawn, and not fed off by ſheep. The ſoil a mixture of gravel and clay. And in the Annals of Agriculture, Vol. VII. and X., ſome important experiments on ſpring wheat are recorded by Mr. Ruggles, of Clare. Seed two and three buſhels per acre; the produce from two to three quarters. Time of ſowing the end of March. Mr. Ruggles obſerves, that this wheat is apt to receive injury from froſt and dry weather. That it requires a dry mouldy ſoil; if moiſt, ſo much the better; but he does not conceive the crop equal to ſpring corn, unleſs the price of wheat ſhould exceed the average difference between that grain and barley, or when, from an uncommon quantity of rain in autumn, the wet lands may not have been ſown. The weight ſixty-three pounds and a quarter each buſhel, containing eight gallons three pints. Mr. Ducket, the Doctor ſays, has cultivated ſpring-wheat on a large ſcale. He drills two buſhels per acre, about the middle of March. He has grown it on the ſame land for three years ſucceſſively. He has reaped this wheat on the 25th of July, got in turnips, and then wheat again in ſpring. And Mr. Marſhall, in his Survey of the Midland Counties, remarks, that ſpring-wheat is cultivated and approved of in that diſtrict. It was likewiſe ſtated in the General Evening Poſt of November 12th, 1800, that in an account of an experiment made that year on the genuine ſpring-wheat:—A perſon at Bridgenorth ſowed ten acres with the above wheat on the 29th and 30th of April, which produced on the average more than twenty-one threaves, common-ſized ſheaf, per acre; and, from a trial made of its produce, yielded more than ſixty quarts of fine wheat per threave. Seven acres was a two-year old clover-ley, cold clay land, ploughed more than ſeven months before ſowing. Four acres of the above ſeven were manured with four hundred buſhels of lime before ſowing, the other three with one hundred buſhels of ſoot ſix weeks after.

The remaining three acres were ſown on rather light land after turnips. The whole ſown on one ploughing, and houſed early in September.

The reſult of the Doctor's extenſive experience on the cultivation of ſpring wheat, is as follows:—1. That it is a diſtinct ſpecies of wheat, as obſerved by Columella, Linnæus, and Ray. He has ſown it in ſpring, at the ſame time, and in the ſame field, with common wheat. The common wheat failed, while the ſpring-wheat roſe to a crop. 2dly, That being liable to be hurt by the froſt, no advantage is gained by early ſowing. That though the proper ſeaſon may be about the middle of April, yet it may be ſown ſo late as the 15th of May, as he found by experience laſt year, when, notwithſtanding the unfavourable ſeaſon, it ripened before barley ſown at the ſame time, and on the ſame field, and was cut on the 20th of September, immediately after the autumn-ſown wheat; the crop two quarters per acre. 3dly, That about two buſhels may be the proper quantity of ſeed per acre; when drilled, leſs; his has been ſown broad-caſt. That the average produce may be about two quarters per acre, unleſs when ſown after turnips fed off by ſheep, when he has gained three quarters per acre. 4thly, That the average value may be about 1s. leſs per buſhel than the common wheat. He ſold this year the ſpring-wheat at 10s. while 11s. was given for the common ſort. 5thly, That being a ſmaller grain than the common wheat, it ripens earlier and with leſs ſun: in a wet harveſt, therefore, it dries ſooner for grinding, as he experienced laſt year. That it receives but little injury from a wet ſummer and autumn, but will ripen earlier than barley in ſuch a ſeaſon. And, 6thly, That when harrowed in on autumn-ſown wheat, in places where the crop has failed, it will ripen at the ſame time without injuring the ſample; which would not be the caſe with either barley or oats. It may therefore, he thinks, on a large farm, deſerve the attention of the huſbandman, and be worth his while always to cultivate a ſmall quantity, as the beſt means of reſtoring a thin wheat crop.—Magazan beans, when dibbled in, will anſwer the ſame purpoſe, but perhaps not equally well, as they may be longer in drying than the wheat*.

But though Dr. Wilkinſon recommends the *Triticum æſtivum* as beſt adapted for ſpring culture, Dr. Pike thinks that in ſome northern parts of the iſland, where the common wheat is generally found to fail when ſown in ſpring, it may probably be ſo: but continues his aſſertion that he has *repeatedly* ſown both the common red or Kentiſh wheat, and the white, *in the ſpring*, and had excellent crops. Dr. Pike has not, however, mentioned the nature of his land.

* Monthly Magazine, Vol. IX. p. 244.

The former of the above writers has likewife given fome ufeful obfervations, the refult of his own experience, on the nature and cultivation of another kind of wheat, ufually known by the title of *Egyptian* or *Prolific wheat*, though little attended to by writers on hufbandry. He found the firft year, on three acres of moift loam, which had been previoufly fallowed, that nine bufhels of feed produced nine quarters of wheat. In the fame field, after a fimilar preparation, the fame proportion of white wheat, fown at the fame time, produced three quarters four bufhels per acre. In both cafes the fallow was dreffed with about one hundred bufhels of lime per acre, at 7d. per bufhel delivered. Four bufhels of the Egyptian wheat, though weighing four pounds more than the fame quantity of white wheat, yet produced twelve pounds lefs of flour, the bran being coarfer and heavier.

After the month of May the growth was more rapid than that of common wheat; on which account, he fhould fuppofe it might be fown with advantage in fpring. The enfuing fpring will prefent a fair opportunity for the trial. The ftraw fo nearly refembles a reed, that it has been called reed wheat. Being heavy and tough, it is cut with difficulty; on which account the reapers require an extraordinary price. It is excellent for thatching, and he has employed it for this purpofe on a large hay-barn. The truffes, on account of their weight, would appear fo fmall that the ftraw would not be faleable in the London market. The ears are bearded like the cone wheat, but in fhape refemble the fquare wheat or rivet. The length of the ftraw and weight of the ear make it liable to lodge.

" On expofing it to fale, he found the millers not inclined to purchafe it. They complain that it is of too horny a nature; that it grinds hard, and obliges them to fet their ftones too clofe. The flour is coarfer and darker than that of the common wheat. A miller who purchafed fome was charged by his cuftomers with grinding rivets. Great part of the crop fold at a price but little above that of good barley. As the crop, though apparently thin on the ground, had yielded three quarters per acre, he entertained hopes that the cultivation might anfwer, even at the price of barley,—if on lighter land, and a warmer foil, he could fecure a larger produce. With this view, therefore, the following year, he fowed on a lighter loam two acres with this wheat, and the remaining fix acres of the field with the common red wheat: the whole on a clover ley. The produce of the red wheat was three quarters per acre, but of the Egyptian not above two quarters per acre; and he found great difficulty in difpofing of it even at the price of barley. He concludes, therefore, that this wheat will not anfwer in this country, where wheat of a fuperior quality can be cultivated to advantage, unlefs it can be introduced

as a ſpring corn. He has ſince met with an account of this grain having been ſown in the ſpring as Egyptian or Siberian barley, under which name it was introduced into this country in the year 1767 *.

The Rev. Dr. Pike has ſown it as ſpring corn in the middle of April, and has had above four quarters per acre. It was on very good land, and kept perfectly clean from weeds. If it be truly a native of Egypt, he ſhould have judged, that a light but very rich ſoil might have been moſt proper for it: nevertheleſs, he thinks he has found, that (like Engliſh rivets) ſtrong land ſuits it beſt. It gives a very bold, plump, ſound grain, of a good colour. He cannot think that it is the ſame as the Siberian wheat (or barley, as ſome have called it). The grains do not anſwer the deſcription which ſome authors give of that ſpecies. That was, he ſays, introduced into this country about the year which Dr. Wilkinſon mentions; but this was known here at leaſt above 120 years before; for he has found a ſhort deſcription, and a tolerably good figure, of it in Parkinſon, page 1120, under the name of *Triticum multiplici ſpicâ*. In the figure, its very remarkable diſtinction from all other ſorts is well expreſſed, by a number of ſhort ears growing out of the ſides of the chief ears. He calls it in Engliſh double-eared wheat, and ſays that it grows about *Lyons* in France†.

To be read after Line 25, *Page* 541.—In Norfolk, wheat is ſeldom ſown after the preparation of a complete ſummer fallowing; there, wheats almoſt invariably ſucceed clover, unleſs a pea or bean crop be interpoſed, and the land is ſcarcely ever fallowed for it, except in the caſe mentioned in note on *baſtard ſummer-tills*.

To be read after Line 8, *Page* 543.—In Norfolk, however, they are in the conſtant habit of ſetting wheat upon a pea-ſtubble with a ſingle ploughing, and conſider it very ſafe and excellent huſbandry: the pea-crop ought to have been kept clean, and, after it is harveſted, the haulm harrowed off. They never plough a bean-ſtubble more than once.

To be read after Line 15, *Page* 550.—An intelligent farmer in Norfolk had, in the year 1800, a piece of drilled wheat, conſiſting of nearly eight acres and a half, unſeeded by the careleſsneſs of his man. The vacant places were dibbled, but to no purpoſe; the vegetation was ſo languid, that, in the courſe of

* Monthly Magazine, Vol. XVI. p. 132. † Ibid.

the winter, all the young ſprouts died, or were eaten up by vermin. On the ſecond of March, 1801, ſome women were hired to take up with a bricklayer's trowel plants of wheat from another field, where the crop was very luxuriant. Theſe were planted into the vacant ſpaces by children, large holes for them being previouſly made by the handle of a ſpade, pointed at its end. The children were watched very attentively, making them arrange the roots of the plants, and with a ſtick break the edges of the holes, that the mould might cover them. Wet weather was purpoſely ſelected for the occaſion; but it proved ſo wet, that they were delayed for more than a week; during the whole of which time two or three wheelbarrows full of plants were lying expoſed on the tumbril ready for inſertion. Theſe plants were uſed, not without ſome apprehenſion. The tranſplanting was not concluded till the 21ſt of the month (March). At harveſt-time it would have been impoſſible to have diſtinguiſhed the tranſplanted from the drilled wheat, but that the plants of the former were placed conſiderably wider from each other. It is imagined, from recollection only, that the plants, on an average, formed ſquares of from twelve to fourteen inches with each other. They branched abundantly, and bore well; the ears were as numerous and as heavy as the drilled wheat. There were certainly four acres tranſplanted. The expenſe of the buſineſs cannot be well eſtimated, becauſe of its irregularity in this particular caſe. At the time it was tranſplanted, wheat ſold at about ſixty-five ſhillings per coomb. Two buſhels an acre would have been inſerted, and the ſetting, on account of the irregularity, would certainly have been twelve ſhillings per acre.

	£.	s.	d.
Setting four acres, at 12s. - -	2	8	0
Two coombs of ſeed, at 65s. - -	6	10	0
	8	18	0

It is not believed that the expenſe of the undertaking much exceeded a fourth part of this. It is ſuppoſed that the whole buſineſs of tranſplanting might be done for thirteen or fourteen ſhillings an acre; and one acre of ſeed plants would ſuffice for a great many acres. When the plants are taken from a crop which is intended to remain, the holes which the trowel makes ſhould be preſſed down with the foot, in order that they may be filled with earth, and not expoſed to drought or too much wet. In trying experiments of this ſort, it is beſt not to venture on too large a ſcale at firſt.

To be read after Line 18, *Page* 573.—Ploughing but once for ſummer corn has however been adviſed by ſome: this practice, it has been obſerved by an intelligent farmer, though certainly not general in the county of Norfolk, is yet by no means uncommon. His crop of barley was never more abundant than it was laſt year from a ſingle ploughing. He has now between forty and fifty acres, which have the appearance of being very productive at the enſuing harveſt, not one acre of which has been ploughed twice. This practice certainly ſaves expenſe, ſaves time, and is very ſimple. He does not, however, mean to recommend it merely becauſe he adopts it himſelf; every man muſt be guided by circumſtances: if his land is foul he muſt clean it, and frequent ploughing is at once the cheapeſt and moſt effectual method he can purſue. If, however, the land be thoroughly cleaned by the uſual laborious preparation for turnips, it cannot be very foul for barley or oats, one of which is moſtly the ſucceeding crop; and he ſuſpects the neceſſity of frequent ploughings for ſummer corn is generally attributable to the ſlovenly injudicious manner in which the ſummer leys for turnips have been managed*.

Without venturing to recommend the practice, a Norfolk farmer ſtates a fact: In the year 1800, he ſowed between forty and fifty acres of barley upon turnip land ploughed only once, and thraſhed ſomewhat more than eleven coombs:—three buſhels per acre. This was in the year of ſcarcity. In 1801, he grew only twenty-four acres of barley; about half of which was drilled, the land having been previouſly pulverized by repeated ploughings, the other half *once* ploughed only, after the turnips were off. The reſult was much in favour of the broad-caſt barley: but it ſhould be obſerved, that the drill did not deliver the ſeed with ſufficient regularity:—he grew eight coombs:—two buſhels round. The year following he ſowed forty-two acres of barley broad-caſt: wanting to bring his land upon ſmaller ridges, he *worked it about:* the crop of barley was very great. He has already thraſhed about ten coombs per acre, and calculates that he has between two and three coombs per acre yet in the ſtraw.

By his advice, his tenant has this year ſown almoſt his whole barley crop with a ſingle ploughing; his turnip-land being clean, with the exception of one piece, which he was adviſed to plough ſeveral times. The weather having continued remarkably dry was the reaſon of the recommendation. By ploughing land two or three times and harrowing it as often in dry weather, whatever moiſture there is muſt evaporate. Corn depoſited in land in this ſituation comes up at two different times; the ſuperficial corn, that which being lightly buried feels the influence of

* Monthly Magazine, Vol. X. p. 132.

dews, and ſprouts up: that which lies deeper will not germinate till a ſhower of rain comes. At harveſt time one half of the farmer's crop would be ſhelled before the other would be ripe. The year before, the ſeed-time was *dropping* as the farmers call it, or he ſhould not have worked his land ſo much about.

To be read after Line 31, *Page* 575.—In oppoſition to an opinion ſtated by Mr. Kerrich, that "out of a coomb of diſcoloured barley, more than two buſhels will not in moſt inſtances work on the malting floor;" and that he is of opinion, it cannot be relied upon for ſeed, "*as the ſeeds do not vegetate better in the ground than they do upon the floor:* an intelligent Norfolk farmer determined to try the vegetative powers of barley in different tints of diſcoloration; and found, as he expected, that the mere circumſtance of diſcoloration had nothing to do with the proceſs of germination when the ſeed is committed to the ground. If the corculum, the ſpeck of vitality, be not injured, the ſeed, he believes, will invariably germinate: the cotyledons are merely organs of nutrition, which convey the oily farinaceous matter of which they are compoſed, to the infant plant: if the nutritious ſubſtance be liberally communicated, which we ſuppoſe to be the caſe when the cotyledons are large, plump and firm, the plant, it is obvious, will thrive better and more rapidly, than when the cotyledons, ſhrunk and ſhrivelled, diſtribute a parſimonious mucilage. Still, however, the deficiency of natural nouriſhment in this latter caſe may, he is perſuaded, be in a great meaſure ſupplied by imparting an additional fecundity to the ſoil. He ſelected from a heap of barley, which lay in his barn, twenty kernels, the moſt thin and meagre which he could find; this was during the ſevereſt part of winter. He planted them in ſome very rich mould, and kept the pot in his ſtudy; where every one of them germinated, tardily indeed at firſt, but the radical fibres ſoon ſpread, and the plants grew luxuriantly. In his garden he afterwards planted ſome of the blackeſt barley he could find, a large proportion of which grew, and was healthy: the corculum of ſome few kernels had been injured, probably rotted by exceſſive rains, and thoſe kernels made no effort to germinate.

In contradiction of the ſecond poſition, he picked from the floor of a neighbouring maltſter ſixty kernels of barley, which having been in the heap (as he was aſſured by him) for nineteen days, had refuſed to malt. He told him, perhaps truly, that thoſe kernels would certainly not vegetate, however long they remained on his floor. He planted them in his garden: and out of ſixty, forty-five grew as rapidly and vigorouſly as he ever ſaw barley in his life. In ſhort, it is evident that warmth and moiſture, however eſſential to germination, are not of themſelves ſufficient to

induce it. Is it not probable, ſays the experimenter, that the corculum of theſe kernels which refuſed to germinate on the floor, was ſtimulated into action by the larger proportion of oxygen which the mould of the garden contained? If ſo, and the fact is very eaſily aſcertained, the maltſter is not ſo much at the mercy of the ſeaſons as Mr. Kerrich would lead us to imagine: he may ſurely contrive to impart a portion of oxygen to his malt-heap without much difficulty, and without much expence.

Encouraged by the ſucceſs of his little experiments on the growth of diſcoloured barley, he ſold his brighteſt corn, and truſted his whole crop to the moſt ordinary and the darkeſt ſeed he had. And the preſent appearance of his crop, conſiſting of more than forty acres, gives him reaſon to expect an abundant produce. Although barley will grow in the ground after having received conſiderable diſcoloration, nay after an incipient germination has taken place in the ear as it has lain on the ground, yet it certainly may be ſo injured as to be very unſafe for ſeed. He agrees, therefore, with Mr. Kerrich in earneſtly recommending to thoſe, who at any future ſeaſon may be diſpoſed to ſow dark barley, "firſt to try a ſmall quantity of what they may reſerve for ſeed, that they may aſcertain whether it will grow or not, before they ſow their general crop*."

* Monthly Magazine, Vol. X. p. 132.

END OF THE FIRST VOLUME.

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ERRATA.

Page 32	Line	1, *for* Cor *read* Cort
182	——	4, — fully *read* full.
206	——	9, — is *read* are
225	——	18, — *the same error*
362	——	15, — † *put* ‡; (*in which cases the references will be right, and the note* † ibid. *will regard the note* *)
362	——	30, *for* is *read* are
363	——	19, *from bottom, the same error*
393	——	17, *for* † *place* ‡
443	——	9, *from bottom, for* prevent *read* preventing
554	——	*last but* 2, *for* salt *read* sand
556	——	23, *for* tomil dew *read* to mildew
557	——	11, — and that in as *read only* and in a
662	——	9, — tuta *read* ruta
709	——	*note* *, *for* Dancus *read* Daucus
740	——	25, *for* crops have *read* crop has
744	——	5, *note, for* closes *read* clauses
751	——	23, *for* craw *read* crow
917	——	14, — grass. husbandry *read* grass-husbandry.